# ENGINEERING CONNECTION ASSESSMENT

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# Engineering Connection Assessment

## P2102 EPC SS-37 Substation Upgrade

ENMAX Power Corporation (EPC)

PROFESSIONAL ENGINEER ALBERTA
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June 16th, 2022
APEGA ID # 280036

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## NOTE:

The conclusions and recommendations in this report are based on the results presented in *Attachment A: Engineering Connection Assessment: Study Results*, which was prepared by a third party consultant in accordance with the AESO Connection Process.

The AESO has reviewed the *Engineering Connection Assessment: Study Results*, and finds it acceptable for the purpose of assessing the potential impacts of the proposed connection on the performance of the Alberta interconnected electric system.

# Contents



# Tables



# Attachments

# 1 Introduction

This AESO Engineering Connection Assessment describes the engineering studies that were completed to assess the impact of the Project (as defined below) on the performance of the Alberta interconnected electric system (AIES). This report also provides the AESO's conclusions and recommendations based on the results of the engineering studies.

Attached to this Engineering Connection Assessment are the results of the engineering studies (see Attachment A) and the scope and methodology used to perform the studies (see Attachment A1 to Attachment A). These attachments provide details regarding the technical criteria, assumptions, and methods for performing these engineering studies, and the results of the engineering studies.

## 1.1 Project Overview

ENMAX Power Corporation (EPC) (Market Participant), in its capacity as the legal owner of an electric distribution system (DFO), has submitted a request for system access service to the Alberta Electric System Operator (AESO) to improve the reliability of the electrical service in the Southeast area of Calgary.

The Market Participant's request includes a request for a Rate DTS, *Demand Transmission Service*, contract capacity increase of 26 MW, from 40 MW to 66 MW, for the system access service provided at SS-37 substation and a request for transmission development (collectively, the Project).

The scheduled in-service date (ISD) for the Project is October 28, 2024.

# 2 Assessment Scope

## 2.1 Objectives

The objectives of the AESO Engineering Connection Assessment are as follows:

- Assess the impact of the Project on the performance of the AIES.
- Evaluate Project connection alternatives and identify the AESO's preferred alternative.
- Recommend mitigation measures, if required, to reliably connect the Project to the AIES.
- Identify Project dependencies, including any TFO projects or AESO plans to expand or enhance the transmission system that must be completed prior to connection.

## 2.2 Existing System

Geographically, the Project is located in the AESO planning area of Calgary (Area 6), which is part of the AESO Calgary planning region. Calgary (Area 6) is surrounded by the planning areas of High River (Area 46), Strathmore (Area 45), Seebe (Area 44), and Airdrie (Area 57).

From a transmission system perspective, Calgary (Area 6) consists primarily of a 240 kV and 138 kV transmission system. Calgary (Area 6) is connected to High River (Area 46), Strathmore (Area 45), and Airdrie (Area 57), Seebe (Area 44), Brooks (Area 47), and Red Deer (Area 35).

Existing constraints in the Calgary planning region are managed in accordance with the procedures set out in Section 302.1 of the ISO rules, Real Time Transmission Constraint Management (TCM Rule).

## 2.3 Study Area

The Study Area for the Project consists of the AESO Planning area of Calgary (Area 6), including the tie lines connecting this planning area to the rest of the AIES. All transmission facilities within the Study Area will be studied and monitored for violations of the Reliability Criteria (defined in Section 3.1 of Attachment A1).

# 3 Connection Alternatives

## 3.1 Overview

The AESO, in consultation with the TFO in the Study Area and the Market Participant, examined five alternatives to meet the DFO's request for system access service, as detailed in Section 3.2.[1]

## 3.2 Connection Alternatives Examined

Below is a description of the developments associated with the transmission alternatives that were examined for the Project.

**Alternative 1 – Distribution Load Transfer**

EPC has determined that load transfer to adjacent substations doesn't meet the EPC Distribution System Performance Standard requirements. Therefore, this alternative is not acceptable as it would not address the reliability concerns over the planning horizon.

**Alternative 2 – Upgrade the existing SS-37 substation**

This alternative includes the following developments:

- Upgrade the existing SS-37 substation, including replacing the existing 13/25 kV transformer with one 138/25 kV transformer, adding one 138 kV circuit breaker; and
- Add or modify associated equipment as required for the above transmission developments

**Alternative 3 –Upgrade the existing SS-38 substation**

This alternative includes the following developments:

- Upgrade the existing SS-38 substation including adding one 138/25 kV transformer, one 138 kV bus-tie breaker;
- Discontinue from use for transmission purposes the existing 13/25 kV 10.13.3 MVA autotransformer at SS-37 substation; and
- Add or modify associated equipment as required for the above transmission developments.

**Alternative 4 –Upgrade the existing SS-24 substation**

This alternative includes the following developments:

[1] These alternatives reflect more up-to-date engineering design than the alternatives identified in EPC's Statement of Need (SON), which is filed under a separate cover.

- Upgrade the existing SS-24 substation including adding one 138/25 kV transformer and one 25 kV feeder breaker; and;
- Add or modify associated equipment as required for the above transmission developments.

**Alternative 5 –New POD with an in-and-out connection to the existing 240 kV transmission line 765L**

This alternative includes the following developments:

- Add one new138/25 kV POD substation, including one 138/25 kV transformer;
- Add two 138 kV circuits, approximately 1 km long each, to connect the new substation to the existing 138 kV transmission line 765L (between the existing Janet 74S and Strathmore 151S substations) using an in-and-out configuration.
- Discontinue from use for transmission purposes the existing 13/25 kV 10/13.3 MVA autotransformer at SS-37 substation; and
- Add or modify associated equipment as required for the above transmission developments.

**Alternative 6 –Upgrade the existing Chestermere 419S substation**

This alternative includes the following developments:

- Upgrade the existing Chestermere 419S substation, including adding one 138/25 kV transformer dedicated for EPC load,;
- Discontinue from use for transmission purposes the existing 13/25 kV 10/13.3 MVA autotransformer at SS-37 substation; and
- Add or modify associated equipment as required for the above transmission developments.

## 3.3 Connection Alternatives Selected for Further Study

Alternative 2 is considered technically feasible and therefore, it is selected for further study.

## 3.4 Connection Alternatives Not Selected for Further Study

Alternative 1 would not address the reliability concerns over the planning horizon, therefore it will not be considered.

Alternative 3 and Alternative 6 are considered technical feasible; however, they require additional distribution feeders to be constructed, which would result in greater losses, greater impact and significantly higher costs compared to Alternative 2 and 4. Therefore, Alternative 3 and Alternative 6 will not be studied.

Alternative 4 is considered technically feasible; however, it has higher transmission and distribution costs as compared to Alternative 2. Therefore, it will be ruled out.

Alternative 5 is also technical feasible; however, it requires the construction of a new substation, which has significantly higher costs compared to alternative 2. Therefore, it will not be studied.

# 4 Assessment Approach

## 4.1 Standards, Criteria and Assumptions

A detailed description of the standards, criteria, and assumptions that were used for the connection assessment is provided in Attachment A (see Attachment A1).

## 4.2 Studies Performed

At the time of study, the scheduled ISD for the Project is May 30, 2025. Therefore, studies were performed using scenarios for 2025 Summer Peak (SP) and 2025 Winter Peak (WP). As the ISD has since shifted to October 2024, the studies herein remain valid for the revised ISD.

Short-circuit studies were performed using the 2025 WP pre-Project scenario, 2025 WP and 2031 WP post-Project scenarios.

Table 4-1 lists the study scenarios. Post-Project scenarios reflect the final requested Rate DTS contract capacity increase of 26 MW at the ENMAX No. 37 Substation (SS-37).

*Table 4-1: Connection Study Scenarios*

| Scenario No. | Year/Season | System Generation Dispatch Conditions | Scenario Name | Project Load (MW) | Project Generation (MW) |
|---|---|---|---|---|---|
| **Pre-Project** | | | | | |
| 1A | 2025 Summer Peak (SP) | Moderate generation in Calgary Area with one Sheppard Energy Centre (SEP) unit offline (N-G) | 2025 SP Pre-Project A | 0 | 0 |
| 2A | 2025 Winter Peak (WP) | | 2025 WP Pre-Project A | 0 | 0 |
| 1B | 2025 SP | High Flow South-North | 2025 SP Pre-Project B | 0 | 0 |
| **Post-Project** | | | | | |
| 3A | 2025 SP | Moderate generation in Calgary Area with one Sheppard Energy Centre (SEP) unit offline (N-G) | 2025 SP Post-Project A | 26 | 0 |
| 4A | 2025 WP | | 2025 WP Post-Project A | 26 | 0 |
| 3B | 2025 SP | High Flow South-North | 2025 SP Post-Project B | 26 | 0 |
| 5 | 2031 WP | All generation in the Study Area ON | 2031 WP Post-Project | 26 | 0 |

The AESO Planning Region load forecasts used for the connection studies were based on the AESO's 2021 Long-term Outlook (2021 LTO).

### *4.2.1 Power Flow Studies*

The purpose of the power flow studies is to identify and quantify any thermal and voltage criteria violations in the Study Area.

In addition, power flow studies are also used to identify POD low voltage bus voltage deviations beyond the limits listed in Table 3-1 of Attachment A1.[2]

Power flow studies were performed for 2025 Summer Peak (SP)-A, 2025 Summer Peak (SP)-B and 2025 Winter Peak (WP)-A Pre-Project scenarios, and for 2025 SP-A, 2025 SP-B, and 2025 WP-A post-Project scenarios.

### 4.2.2 Voltage Stability Studies

The purpose of the voltage stability studies is to determine the ability of the transmission system to maintain voltage stability at the busses in the Study Area.

Voltage stability studies were performed for 2025 WP-A and 2025 SP-A post-Project scenarios.

### 4.2.3 Short-Circuit Current Level Studies

The purpose of short-circuit current level studies is to determine the expected system short-circuit current levels in the vicinity of the Project.

Short circuit studies were performed for the 2025 WP pre-Project scenario, 2025 WP and 2031 WP post-Project scenarios.

[2] The AESO's desired post-contingency voltage deviations for low voltage busses represent guidelines rather than criteria. A POD bus voltage deviation that exceeds the desired limits shown in Table 3-1 of Attachment A1 does not represent a Reliability Criteria violation. Mitigation measures would not be developed to specifically address POD bus voltage deviations that exceed the desired values in Table 3-1 of Attachment A1.

# 5 Results

## 5.1 Overview

Under Category A and Category B conditions, no Reliability Criteria violations or POD bus voltage deviations were observed.
The short-circuit current levels were found to be within the typical capability of the nearby facilities.

Detailed study results are provided in Attachment A.

# 6 Project Dependencies

The Project does not require the completion of any other AESO plans to expand or enhance the transmission system prior to connection.

# 7 Conclusions and Recommendations

Based on the study results, Alternative 2 is technically viable and will not adversely affect the performance of the transmission system. The connection assessment did not identify any system performance issues in the pre-Project and post-Project scenarios studied.

The AESO recommends proceeding with the Project using Alternative 2 as the preferred alternative to respond to the DFO's request for system access service.

Alternative 2 involves upgrading the existing SS-37 substation, replacing the existing 13/25 kV transformer with one 138/25 kV transformer, and adding one 138 kV circuit breaker. The DFO has advised that this alternative will also require the addition of 11 25 kV circuit breakers.

It is recommended that the 138/25 kV transformer at SS-37 substation have a transformation capability of 50 MVA, based on the requested Rate DTS contract capacity increase and the DFO's distribution system performance standard for their substations.

# Attachment A:
# Engineering Connection Assessment Results

# Engineering Connection Assessment: Study Results

## P2102 EPC East Calgary Area Load

ENMAX Power Corporation (EPC)

May 26, 2022
PROFESSIONAL ENGINEER
BUSAYO AKINLOYE
ALBERTA

**Date:** April 25, 2022

**Version:** V1D2

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**PERMIT TO PRACTICE**
**ENMAX POWER CORPORATION**

RM SIGNATURE: ______

RM APEGA ID #: 80449

DATE: May 26/22

**PERMIT NUMBER: P006756**

The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

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# Tables



# Attachments

# 1 Introduction

This report presents the results of the engineering studies that were completed by ENMAX Power Corporation (EPC) (the Studies Consultant) to assess the impact of the Project (as defined in Attachment A1: AESO Engineering Connection Assessment Scope) on the performance of the Alberta interconnected electric system (AIES). The studies were performed in accordance with Attachment A1: AESO Engineering Connection Assessment: Study Scope, which was prepared by the AESO.

The power system network analysis tool that was used for the studies in this connection assessment was PSS/E version 34.

# 2 Pre-Project Study Results

This section describes the results of the pre-Project power flow studies.

## 2.1 Power Flow Studies

Power flow diagrams illustrating the pre-Project power flow studies results for Category A and Category B conditions are provided in Attachment A2.

### *2.1.1 Scenario 1: 2025 SP Pre-Project A*

**Category A Conditions**

No Reliability Criteria (as defined in Section 3.1 of Attachment A1) violations were observed under Category A conditions.

**Category B Conditions**

No Reliability Criteria violations were observed under Category B conditions.

*Voltage Criteria Violations*

No voltage criteria violations were observed under Category B conditions.

*POD Bus Voltage Deviations*

No voltage deviations beyond the limits listed in Table 3-1 of Attachment A1 (hereafter referred to as point of delivery (POD) bus voltage deviations) were observed.

### *2.1.2 Scenario 2: 2025 WP Pre-Project A*

**Category A Conditions**

No Reliability Criteria (as defined in Section 3.1 of Attachment A1) violations were observed under Category A conditions.

**Category B Conditions**

No Reliability Criteria violations were observed under Category B conditions.

*Voltage Criteria Violations*

No voltage criteria violations were observed under Category B conditions.

*POD Bus Voltage Deviations*

No voltage deviations beyond the limits listed in Table 3-1 of Attachment A1 (hereafter referred to as point of delivery (POD) bus voltage deviations) were observed

### *2.1.3 Scenario 3: 2025 SP Pre-Project B*

**Category A Conditions**

No Reliability Criteria (as defined in Section 3.1 of Attachment A1) violations were observed under Category A conditions.

**Category B Conditions**

No Reliability Criteria violations were observed under Category B conditions.

*Voltage Criteria Violations*

No voltage criteria violations were observed under Category B conditions.

*POD Bus Voltage Deviations*

No voltage deviations beyond the limits listed in Table 3-1 of Attachment A1 (hereafter referred to as point of delivery (POD) bus voltage deviations) were observed.

# 3 Post-Project Study Results

This section describes the results of the post-Project power flow studies and voltage stability studies.

## 3.1 Power Flow Studies

Power flow diagrams illustrating the post-Project power flow studies results for Category A and Category B conditions are provided in Attachment A3.

### *3.1.1 Scenario 5: 2025 SP Post-Project A*

**Category A Conditions**

No Reliability Criteria violations were observed under Category A conditions.

**Category B Conditions**

No Reliability Criteria violations were observed under Category B conditions.

*Voltage Criteria Violations*

No voltage criteria violations were observed under Category B conditions.

*POD Bus Voltage Deviations*

No POD bus voltage deviations were observed.

### *3.1.2 Scenario 6: 2025 WP Post-Project A*

**Category A Conditions**

No Reliability Criteria violations were observed under Category A conditions.

**Category B Conditions**

No Reliability Criteria violations were observed under Category B conditions.

*Voltage Criteria Violations*

No voltage criteria violations were observed under Category B conditions.

*POD Bus Voltage Deviations*

No POD bus voltage deviations were observed.

### *3.1.3 Scenario 7: 2025 SP Post-Project B*

**Category A Conditions**

No Reliability Criteria violations were observed under Category A conditions.

### Category B Conditions

No Reliability Criteria violations were observed under Category B conditions.

*Voltage Criteria Violations*

No voltage criteria violations were observed under Category B conditions.

*POD Bus Voltage Deviations*

No POD bus voltage deviations were observed.

## 3.2 Voltage Stability Studies

### *3.2.1 Scenario 5: 2025 SP Post-Project A*

Voltage stability analysis was performed for the 2025 SP Post-Project A scenario. The reference load level for the Study Area is 1,605 MW. For Category B contingencies, the minimum incremental load transfer is 5% of the reference load, or 80.25 MW (0.05 x 1,605 MW = 80.25 MW), to meet the voltage stability criteria.

Table 3-1 provides the voltage stability study results under the Category A condition and for the five worst contingencies under Category B conditions. The voltage stability diagrams are provided in Attachment A4.

The voltage stability margin was met for all studied conditions

***Table 3-1: Voltage Stability Study Results under Category B Conditions for Scenario 5***

| **Contingency (System Element Lost)** | **From** | **To** | **Maximum Incremental Transfer (MW)** | **Maximum Incremental Transfer (%)** | **Meets Criteria?** |
|---|---|---|---|---|---|
| N-0 | System Normal | | 810 | 52.1 | Yes |
| 906L | 155 | 161 | 740 | 47.6 | Yes |
| 928L | 155 | 161 | 740 | 47.6 | Yes |
| 918L | 187 | 639 | 770 | 49.5 | Yes |
| 37.82L | 207 | 574 | 770 | 49.5 | Yes |
| PCE02L | 198 | 290 | 750 | 48.2 | Yes |

### *3.2.2 Scenario 6: 2025 WP Post-Project A*

Voltage stability analysis was performed for the 2025 WP Post-Project A scenario. The reference load level for the Study Area is 1,618 MW. For Category B contingencies, the minimum incremental load transfer is 5% of the reference load, or 80.9 MW (0.05 x 1,618 MW = 80.9 MW), to meet the voltage stability criteria.

Table 3-1 provides the voltage stability study results under the Category A condition and for the five worst contingencies under Category B conditions. The voltage stability diagrams are provided in Attachment A4.

The voltage stability margin was met for all studied conditions

***Table 3-2: Voltage Stability Study Results under Category B Conditions for Scenario 6***

| Contingency (System Element Lost) | From | To | Maximum Incremental Transfer (MW) | Maximum Incremental Transfer (%) | Meets Criteria? |
|---|---|---|---|---|---|
| N-0 | System Normal | | 970 | 62.6 | Yes |
| 906L | 155 | 161 | 900 | 58.1 | Yes |
| 928L | 155 | 161 | 900 | 58.1 | Yes |
| 918L | 187 | 639 | 930 | 60.1 | Yes |
| 37.82L | 207 | 574 | 910 | 58.8 | Yes |
| WATL | 159 | 485 | 880 | 56.8 | Yes |

# 4 Short Circuit Studies

## 4.1 Pre-Project Results

Pre-Project short-circuit current levels are provided in Table 4-1[1].

***Table 4-1: Pre-Project Short-Circuit Current Levels for 2025 WP Pre-Project B***

| Substation Name and Number | Base Voltage (kV) | Pre-Fault Voltage (kV) | 3-Φ Fault (kA) | Positive Sequence Thevenin Source Impedance (R1+jX1) (pu) | 1-Φ Fault (kA) | Zero Sequence Thevenin Source Impedance (R0+jX0) (pu) |
|---|---|---|---|---|---|---|
| ENMAX No. 23 | 138.0 | 139.804 | 21.888 | 0.924+3.679j | 14.960 | 1.553+8.969j |
| ENMAX No. 24 | 138.0 | 139.669 | 24.429 | 0.802+3.304j | 19.641 | 0.901+5.857j |
| ENMAX No. 37 | 138.0 | 139.987 | 22.636 | 0.923+3.554j | 15.652 | 1.473+8.503j |
| ENMAX No. 38 | 138.0 | 140.068 | 29.372 | 0.653+2.756j | 26.604 | 0.449+3.733j |
| ENMAX No. 39 | 138.0 | 140.339 | 25.930 | 1.219+5.596j | 25.624 | 0.994+5.978j |
| JANET 74S | 240.0 | 249.657 | 5.120 | 0.278+3.009j | 5.430 | 0.072+2.507j |
| | 138.0 | 140.156 | 5.312 | 0.328+2.885j | 5.611 | 0.08+2.444j |

## 4.2 Post-Project Results

### *4.2.1 Scenario 5: 2025 WP Post-Project B*

Post-Project short-circuit current levels for 2025 WP Post-Project B are provided in Table 4-2.

***Table 4-2: Post-Project Short-Circuit Current Levels for 2025 WP Post-Project B***

| Substation Name and Number | Base Voltage (kV) | Pre-Fault Voltage (kV) | 3-Φ Fault (kA) | Positive Sequence Thevenin Source Impedance (R1+jX1) (pu) | 1-Φ Fault (kA) | Zero Sequence Thevenin Source Impedance (R0+jX0) (pu) |
|---|---|---|---|---|---|---|
| ENMAX No. 23 | 138.0 | 140.079 | 21.971 | 0.931+3.667j | 14.996 | 1.553+8.969j |
| ENMAX No. 24 | 138.0 | 139.928 | 24.542 | 0.811+3.288j | 19.697 | 0.901+5.857j |
| ENMAX No. 37 | 138.0 | 140.044 | 22.717 | 0.928+3.546j | 15.692 | 1.473+8.503j |
| ENMAX No. 38 | 138.0 | 140.191 | 29.502 | 0.659+2.746j | 26.693 | 0.449+3.733j |
| ENMAX No. 39 | 138.0 | 140.524 | 26.044 | 1.227+5.584j | 25.722 | 0.994+5.978j |

[1] Short-circuit current studies were based on modeling information provided to the AESO by third parties. The authenticity of the modeling information has not been validated. Fault levels could change as a result of system developments, new customer connections, or additional generation in the area. It is recommended that these changes be monitored and fault levels reviewed to ensure that the fault levels are within equipment operating limits. The information provided in this study should not be used as the sole source of information for electrical equipment specifications or for the design of safety-grounding systems.

| | | | | | | |
|---|---|---|---|---|---|---|
| JANET 74S | 240.0 | 250.296 | 5.082 | 0.28+3.005j | 5.389 | 0.072+2.507j |
| | 138.0 | 140.339 | 5.323 | 0.327+2.885j | 5.623 | 0.08+2.444j |

### 4.2.2 Scenario 5: 2031 WP Post-Project

Post-Project short-circuit current levels for 2031 WP Post-Project are provided in Table 4-3.

***Table 4-3: Post-Project Short-Circuit Current Levels for 2031 WP Post-Project***

| Substation Name and Number | Base Voltage (kV) | Pre-Fault Voltage (kV) | 3-Φ Fault (kA) | Positive Sequence Thevenin Source Impedance (R1+jX1) (pu) | 1-Φ Fault (kA) | Zero Sequence Thevenin Source Impedance (R0+jX0) (pu) |
|---|---|---|---|---|---|---|
| ENMAX No. 23 | 138.0 | 139.226 | 21.845 | 0.891+3.607j | 14.829 | 1.535+8.897j |
| ENMAX No. 24 | 138.0 | 138.998 | 24.492 | 0.765+3.22j | 19.583 | 0.879+5.771j |
| ENMAX No. 37 | 138.0 | 139.596 | 22.567 | 0.892+3.494j | 15.515 | 1.458+8.441j |
| ENMAX No. 38 | 138.0 | 139.795 | 29.647 | 0.608+2.67j | 26.743 | 0.43+3.646j |
| ENMAX No. 39 | 138.0 | 140.191 | 26.498 | 1.113+5.415j | 26.036 | 0.967+5.871j |
| JANET 74S | 240.0 | 252.130 | 4.927 | 0.313+3.007j | 5.227 | 0.072+2.507j |
| | 138.0 | 139.777 | 5.205 | 0.309+2.887j | 5.517 | 0.079+2.415j |

# Attachment A1
# Engineering Connection Assessment: Study Scope

# Engineering Connection Assessment: Study Scope

## P2102 EPC East Calgary Area Load

### ENMAX Power Corporation (EPC)

**Date:** May 16, 2022

**Version:** V1

**Classification:** Public

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# Tables

# Figures



# Attachments

# 1 Introduction

This Study Scope provides an overview of the engineering studies to be completed by ENMAX Power Corporation (EPC, the Studies Consultant) to assess the impact of the Project (as defined in section 1.1) on the performance of the Alberta interconnected electric system (AIES). Technical criteria, assumptions and methods for performing these engineering studies are provided in this document.

## 1.1 Project Overview

EPC, in its capacity as the legal owner of an electric distribution system (DFO), has submitted a request for system access service to the Alberta Electric System Operator (AESO) to increase the capacity at ENMAX No. 37 Substation (SS-37) located in the Calgary planning area.

The DFO's request includes a request for a Rate DTS, Demand Transmission Service, contract capacity increase of 26 MW, from 40 MW to 66 MW, for the system access service provided at SS-37 and a request for transmission development (collectively, the Project). Details on the need for the enhancement can be found in the DFO's Statement of Need (SON).

The Project in-service date (ISD) used for the purpose of the studies is October 28, 2024.

There are no generation components of the Project.

***Table 1-1: Project Load and Generation Details***

| Project Component | | Description |
|---|---|---|
| Load | Existing Rate DTS, *Demand Transmission Service,* contract capacity | 40 MW at SS-37 |
| | Requested Rate DTS | An increase of 26 MW at SS-37 to 66 MW |
| | Type | residential, commercial, industrial |
| | Motors (number and size) | N/A |
| | Power factor | 0.9 pf |
| | Future load expansion plans | No |

**Note:**

MARP and MC are defined in the AESO's *Consolidated Authoritative Document Glossary*, which can be found on the AESO's website.

## 1.2 Existing System Overview

### *1.2.1 Study Area*

Geographically, the Project is located in the AESO planning area of Calgary (Area 6), which is part of the AESO Calgary planning region.

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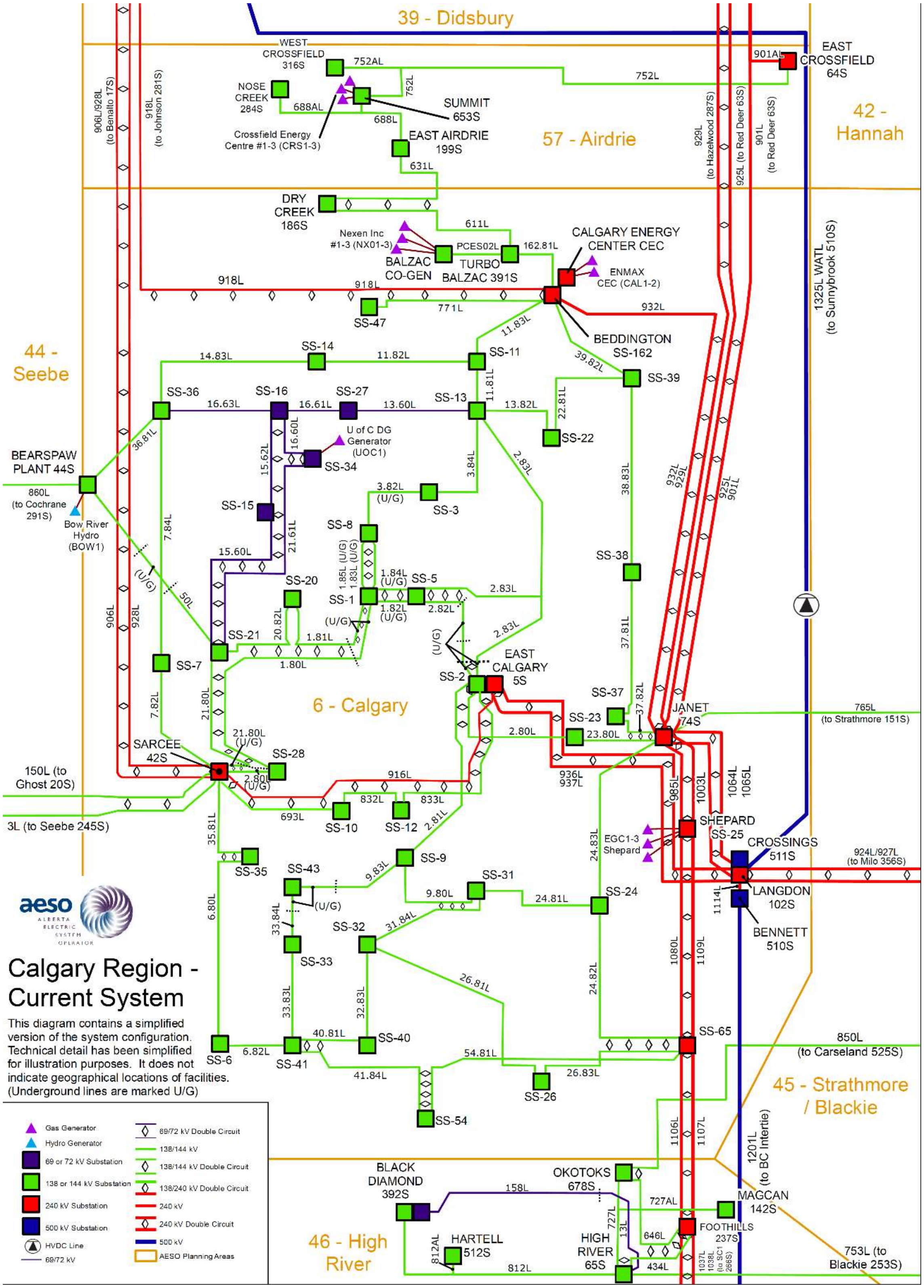
The Study Area consists of Calgary Area (Area 6), including the tie lines connecting this planning area to the rest of the AIES.

The existing transmission system in the Study Area is shown in Figure 1-1.

***Figure 1-1: Transmission System in the Study Area***



### 1.2.2 Existing Constraints

Existing constraints in the Study Area are managed in accordance with the procedures set out in Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management* (TCM Rule).

There are a number of constraints in the Study Area that are mitigated by existing remedial action schemes (RASs) and/or other protection schemes.

The following existing RASs and/or other protection schemes are used to manage constraints in the area:

- RAS 11. Bennett 520S Underfrequency And Power Scheme
- RAS 12. Bennett 520S Undervoltage & Power Scheme
- RAS 133. Beddington 162S Overload Mitigation Scheme
- RAS 136. Direct Transfer Trip to MATL on Loss of 1201L
- RAS 145. Shepard RAS - Mitigation of 138 kV Thermal Constraints on ENMAX System
- RAS 153. Mitigation of 138 kV Thermal Constraints on ENMAX System at SS-65
- RAS 157. Chestermere 419S Overload and Voltage Stability Mitigation

# 2 Connection Alternative for Stage 3 to be Studied

The following alternative will be studied:

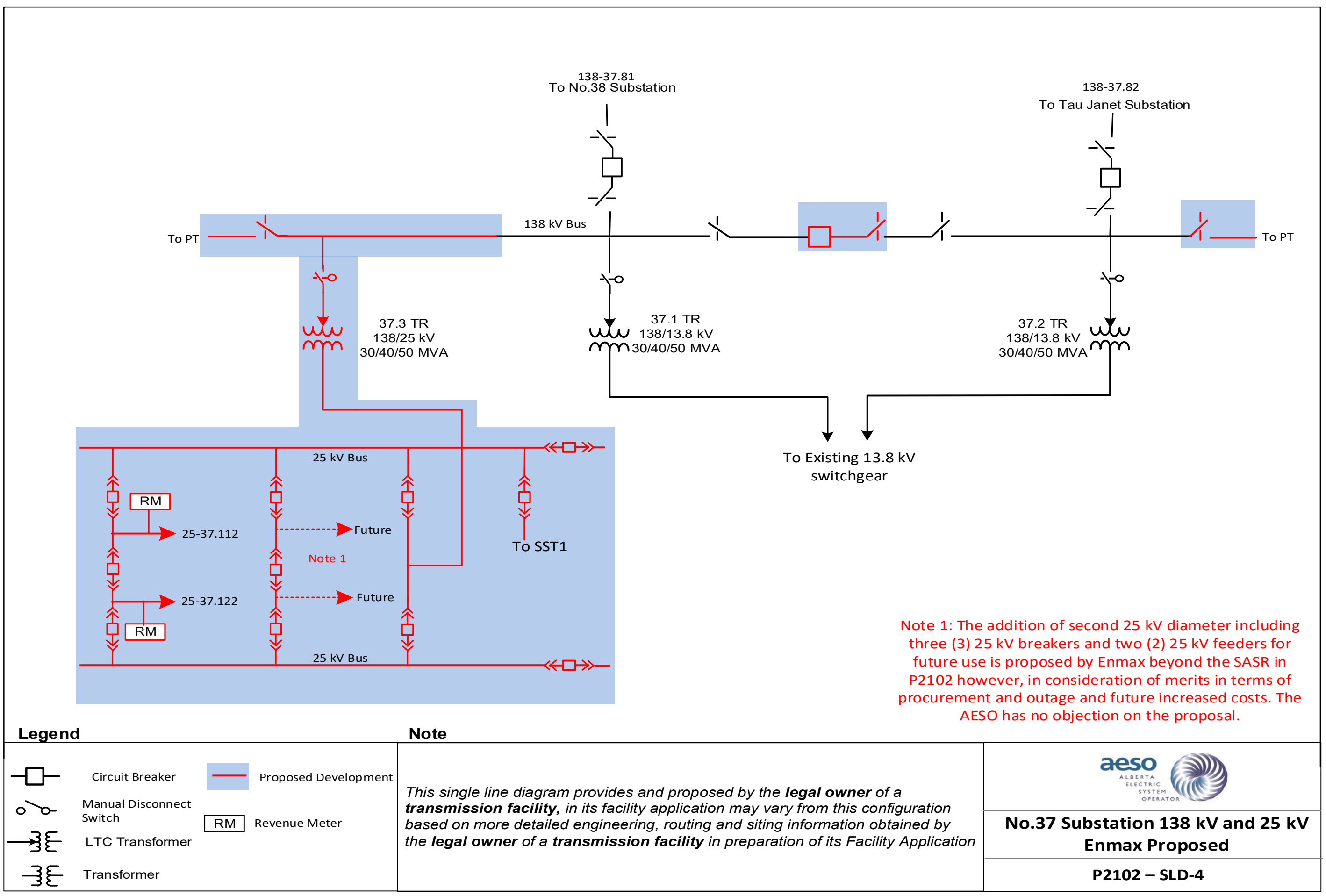
## 2.1 Alternative 2 –Upgrade the existing SS-37 substation

This alternative includes the following developments:

- Upgrade the existing SS-37 substation, including replacing the existing 13/25 kV transformer with one 138/25 kV transformer, adding one 138 kV circuit breaker and eleven 25 kV circuit breakers; and
- Add or modify associated equipment as required for the above transmission developments

The proposed connection configuration is shown in Figure 2-1.

***Figure 2-1: Connection Alternative 2***



# 3 Criteria, Standards and Requirements

## 3.1 AESO Reliability Criteria

The Transmission Planning (TPL) Standards, which are included in the Alberta Reliability Standards, and *Transmission Planning Criteria – Basis and Assumptions (see Attachment A),* (collectively, the Reliability Criteria) will be applied to evaluate system performance under Category A system conditions (i.e., all elements in-service) and following Category B contingencies (i.e., single element outage), prior to and following the studied alternatives. Below is a summary of Category A and Category B system conditions.

**Category A**, often referred to as the N-0 condition, represents a normal system with no contingencies and all facilities in service. Under this condition, the system must be able to supply all firm load and firm transfers to other areas. All equipment must operate within its applicable rating, voltages must be within their applicable range, and the system must be stable with no cascading outages.

**Category B** events, often referred to as an N-1 or N-G-1 with the most critical generator out of service, result in the loss of any single specified system element under specified fault conditions with normal clearing. These elements are a generator, a transmission circuit, a transformer, or a single pole of a DC transmission line. The acceptable impact on the system is the same as Category A. Planned or controlled interruptions of electric supply to radial customers or some local network customers, connected to or supplied by the faulted element or by the affected area, may occur in certain areas without impacting the overall reliability of the interconnected transmission systems. To prepare for the next contingency, system adjustments are permitted, including curtailments of contracted firm (non-recallable reserved) transmission service electric power transfers.

The TPL standards, TPL-001-AB-0 and TPL-002-AB1-0, have referenced Applicable Ratings when specifying the required system performance under Category A and Category B events. For the purpose of applying the TPL standards to the studies documented in this report, Applicable Ratings are defined as follows:

- Normal thermal rating of the line's loading limits for each season;
- The highest specified loading limits for transformers;
- For Category A conditions: Voltage range under normal operating condition per AESO Information Document #2010-007RS, *General Operating Practices – Voltage Control* (ID #2010-007RS). For the busses not listed in ID #2010-007RS, Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions* applies;
- For Category B conditions: The extreme voltage range values per Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions; and*
- Desired post-contingency voltage deviation limits for three defined post-event timeframes as provided in Table 3-1.

***Table 3-1: Post-Contingency Voltage Deviation Guidelines for Low Voltage Busses***

| Parameter and reference point | Time Period | | |
|---|---|---|---|
| | Post Transient (up to 30 sec) | Post Auto Control (30 sec to 5 min) | Post Manual Control (Steady State) |
| Voltage deviation from steady state at point of delivery (POD) low voltage bus. | ±10% | ±7% | ±5% |

## 3.2 ISO Rules and Information Documents

ID #2010-007RS will be used to establish system normal (i.e., pre-contingency) voltage profiles for the Study Area.

The TCM Rule will be followed to set up the study scenarios and assess the impact of the Project. In addition, due regard will be given to the following:

- The AESO's *Connection Study Requirements*;
- Section 502.7 of the ISO rules, *Load Facility Technical Requirements*;

# 4 Scenarios and Assumptions

## 4.1 Scenarios

The following section describes the scenarios to be studied and the assumptions to be used in the studies.

Connection scenarios must be studied as outlined in Table 4-1.

***Table 4-1: Connection Study Scenarios***

| Scenario No. | Year/Season | System Generation Dispatch Conditions | Scenario Name | Project Load (MW) | Project Generation (MW) |
|---|---|---|---|---|---|
| **Pre-Project** | | | | | |
| 1A | 2025 Summer Peak (SP) | Moderate generation in Calgary Area with one Sheppard Energy Centre (SEP) unit offline (N-G) | 2025 SP Pre-Project A | 0 | 0 |
| 2A | 2025 Winter Peak (WP) | | 2025 WP Pre-Project A | 0 | 0 |
| 1B | 2025 SP | High Flow South-North | 2025 SP Pre-Project B | 0 | 0 |
| **Post-Project** | | | | | |
| 3A | 2025 SP | Moderate generation in Calgary Area with one Sheppard Energy Centre (SEP) unit offline (N-G) | 2025 SP Post-Project A | 26 | 0 |
| 4A | 2025 WP | | 2025 WP Post-Project A | 26 | 0 |
| 3B | 2025 SP | High Flow South-North | 2025 SP Post-Project B | 26 | 0 |
| 5 | 2031 WP | All generation in the Study Area ON | 2031 WP Post-Project | 26 | 0 |

## 4.2 Assumptions

### *4.2.1 System Project Assumptions*

The pre-Project and post-Project connection assessment will not include any system transmission projects because there are no planned system transmission developments in the Study Area that are expected to be in service before the scheduled Project ISD.

### *4.2.2 Connection Project Assumptions*

The pre-Project and post-Project connection assessment will not include any other connection projects in the Study Area.

### *4.2.3 Load Assumptions*

The load forecast to be used for the studies is shown in Table 4-2 and is a forecast for the AESO Calgary Planning Region peak based on the *AESO 2021 Long-term Outlook* (2021 LTO)[1] with modifications to incorporate the latest forecast intelligence. For the post-Project studies, when the Study Area loads are modified to align with the regional load forecast, the active power to reactive power ratio in the base case scenarios shall be maintained.

***Table 4-2: Forecast Load (at AESO Calgary Planning Region Peak)***

| AESO Planning Region Name | Forecast Peak Load by Year/Season (MW) | |
|---|---|---|
| | 2025 SP | 2025 WP |
| Calgary Planning Region[1] | 1,605 | 1,618 |

**Note:**
[1] The Calgary Region comprises the following AESO planning areas: Calgary (Area 6) and Airdrie (Area 57)

IDEV files contain non-motor loads in zones 34, 36, and 351. These loads are not accounted for in the forecasted peak loads shown above and should not be considered when scaling load. The AESO engineer will provide guidance to load scaling procedures as required.

### *4.2.4 Generation Assumptions*

The generation forecast to be used for the studies is based on the 2021 LTO with modifications to incorporate the latest forecast intelligence. The generation assumptions for the studies will assume Economic generation dispatch condition. Additional studies may be required in the event of changes to the AESO's corporate forecast.

The existing generation (excluding wind and solar) dispatch conditions for the study scenarios are described in Table 4-3.

Sheppard Energy Centre (SEP) unit 3 was determined to be the critical generator and shall be modelled as being offline to simulate the N-G condition in the corresponding study scenarios.

The wind and solar generation dispatch for the High South to North Flow scenarios is shown in Table 4-4, Table 4-5, Table 4-6, and Table 4-7[2].

[1] The 2021 LTO is available on the AESO website.

[2] To re-adjust the intertie, scale generation in the Edmonton and North-East Regions.

*Table 4-3: Existing Generation (excluding Wind and Solar) Dispatch Conditions*

| Facility | Unit | Bus Number | Area | Pmax (MW) | Unit Net Generation (MW) | | |
|---|---|---|---|---|---|---|---|
| | | | | | N-G Dispatch | | High South to North Flow |
| | | | | | 2025 SP | 2025 WP | 2025 SP |
| Shepard Energy Centre | GT2 | 774 | 6 | 276 | N-G | N-G | 767 |
| | GT1 | 775 | 6 | 276 | 477 | 492 | |
| | ST1 | 773 | 6 | 318 | | | |
| Calgary Energy Centre | GT1 | 4187 | 6 | 190 | 210 | 235 | 210 |
| | ST1 | 3187 | 6 | 135 | | | |
| Balzac | GT1 | 3290 | 6 | 64.1 | 40 | 47 | 40 |
| | GT2 | 4290 | 6 | 64.1 | | | |
| | ST1 | 4290 | 6 | 26.5 | | | |
| University of Calgary | GT1 | 2556 | 6 | 15 | 11 | 13 | 11 |

**Notes:**
[a] "Unit Net Generation" refers to gross generating unit output (MW) less unit service load.
[b] "N-G" indicates the critical generating unit that is assumed by the AESO to be offline to test the N-G contingency condition

*Table 4-4: Dispatch Conditions for Existing and Under Construction Wind Generation Facilities*

| Facility Name and Code | AESO Planning Area No. | Bus No. | MC (MW) | Unit Net Generations (MW) |
|---|---|---|---|---|
| | | | | 2025 SP |
| Ardenville Wind (ARD1) | 53 | 4735, 4740 | 68 | 54.4 |
| Blackspring Ridge (BSR1) | 49 | 61736, 61737 | 300 | 240.0 |
| Blue Trail Wind (BTR1) | 53 | 66328, 67328 | 66 | 52.8 |
| Bull Creek (BUL1 & BUL2) | 37 | 550003, 550004 | 29.5 | 23.6 |
| Castle River #1 (CR1) | 53 | 2234, 3234 | 39 | 31.2 |
| Castle Rock Ridge 2 (CRR2) | 53 | 567221 | 30.6 | 24.5 |
| Castle Rock Wind Farm (CRR1) | 53 | 67221 | 77 | 61.6 |
| Cowley Ridge (CRE3) | 53 | 4264 | 20 | 16.0 |
| Enmax Taber (TAB1) | 52 | 15343, 16343 | 81 | 64.8 |
| Ghost Pine (NEP1) | 42 | 2621, 2622, 2623, 2624, 2625 | 82 | 65.6 |
| Halkirk Wind Power Facility (HAL1) | 42 | 66435, 67435 | 150 | 120.0 |
| Kettles Hill (KHW1) | 53 | 2402, 3402 | 63 | 50.4 |
| McBride Lake Windfarm (AKE1) | 53 | 2901, 3901, 4901 | 73 | 58.4 |

| Facility Name and Code | AESO Planning Area No. | Bus No. | MC (MW) | Unit Net Generations (MW) |
|---|---|---|---|---|
| | | | | 2025 SP |
| Old Man River(OWF1) | 53 | 61543 | 46 | 36.8 |
| Riverview Wind Farm (RIV1) | 53 | 69221 | 115 | 92.0 |
| Soderglen Wind (GWW1) | 53 | 12358, 13358 | 71 | 56.8 |
| Summerview 1 (IEW1) | 53 | 2338, 3338 | 66 | 52.8 |
| Summerview 2 (IEW2) | 53 | 4339, 5337 | 66 | 52.8 |
| Suncor Chin Chute (SCR3) | 54 | 2389 | 30 | 24.0 |
| Suncor Magrath (SCR2) | 53 | 11002 | 30 | 24.0 |
| Suncor Wintering Hills (SCR4) | 43 | 60789, 60791, 60793, 60846, 60848, 60850 | 88 | 70.4 |
| Whitla Wind Power Facility (WHT1) | 4 | 60990 | 201.6 | 161.3 |
| Whitla Wind Power Facility (WHT2) | 4 | 61990, 64990 | 151.2 | 121.0 |
| Windrise (WRW1) | 53 | 567031 | 207 | 165.6 |

**Note:**
[a] "Unit Net Generation" refers to gross generating unit output (MW) less unit service load.

***Table 4-5: Dispatch Conditions for Existing and Under Construction Solar Generation Facilities***

| Facility Name and Code | AESO Planning Area No. | Bus No. | MC (MW) | Unit Net Generations (MW) |
|---|---|---|---|---|
| | | | | 2025 SP |
| Brooks Solar (BSC1) | 47 | 553257 | 15 | 12.0 |
| Hull DER Solar (HUL1) | 52 | 2401 | 24.5 | 19.6 |
| Vauxhall Solar (VXH1) | 52 | 4274 | 22 | 17.6 |
| Suffield Solar (SUF1) | 4 | 3270 | 23 | 18.4 |
| Claresholm Solar (CLR1) | 49 | 60894 | 58 | 46.4 |
| Claresholm Solar (CLR2) | 49 | 61894 | 75 | 60.0 |
| Burdett (BRD1) | 52 | 2269 | 11 | 8.8 |
| Westfield Yellow Lake (WEF1) | 52 | 557277 | 19 | 15.2 |
| Burdett (BUR1) | 52 | 557269 | 20 | 16.0 |
| Hays Solar | 52 | 554401 | 24 | 19.2 |
| Jenner Solar DER | 48 | 554986 | 23 | 18.4 |
| Innisfail Solar (INF1) | 39 | 557120 | 22 | 17.6 |

| Facility Name and Code | AESO Planning Area No. | Bus No. | MC (MW) | Unit Net Generations (MW) |
|---|---|---|---|---|
| | | | | 2025 SP |
| P2362 Fortis Enchant 447S DER Solar | 52 | 993287 | 22 | 17.6 |
| P2363 Fortis Enchant 447S DER Solar | 52 | 993289 | 18 | 14.4 |
| P2364 Fortis Enchant 447S DER Solar | 52 | 994287 | 9 | 7.2 |
| P2365 Fortis Enchant 447S DER Solar | 52 | 994289 | 23 | 18.4 |

**Note:**
[a] "Unit Net Generation" refers to gross generating unit output (MW) less unit service load.

***Table 4-6: Dispatch Conditions for Planned Wind Generation Projects***

| Facility Name and Code | Bus No. | Planned ISD | Planning Area No. | AESO Stage | MC (MW) | Unit Net Generations (MW) |
|---|---|---|---|---|---|---|
| | | | | | | 2025 SP |
| P1892 Fortis Buffalo Atlee Cluster 3 WAGF | 552260 | 1-Dec-21 | 47 | 3 | 17.3 | 13.8 |
| P1853 Fortis Buffalo Atlee Cluster 1 WAGF | 553260 | 1-Dec-21 | 47 | 3 | 17.3 | 13.8 |
| P2199 Buffalo Atlee Wind Farm 2 | 557261 | 1-Dec-21 | 47 | 3 | 13.8 | 11.0 |
| P1719 Stirling WAGF Project | 61630 | 1-Nov-22 | 54 | 5 | 113 | 90.4 |
| P2122 EDF Cypress Wind | 560003 | 1-Nov-22 | 4 | 5 | 201.6 | 161.3 |
| P1533 Joss MPC WAGF | 60798, 60799 | 30-Jun-22 | 47 | 5 | 122 | 97.6 |
| P1698 Joss Jenner WAGF - Phase 2 | 61798, 61799 | 30-Jun-22 | 47 | 3 | 71.4 | 57.1 |
| P1812 Suncor Forty Mile Granlea WAGF | 61994, 62994 | 16-Nov-21 | 4 | 5 | 200 | 160.0 |
| P2212 RES Rattlesnake Ridge | 60873 | 30-Jul-21 | 4 | 5 | 117.6 | 94.1 |
| P1718 Wheatland WAGF Project | 60632, 61632 | 30-Jun-22 | 43 | 5 | 120 | 96.0 |
| P1909 TransAlta Garden Plain Wind | 565002 | 1-Jul-22 | 42 | 4 | 130 | 104.0 |
| P2234 Jenner Wind Phase 3 | 61799 | 30-Jun-22 | 48 | 3 | 109.2 | 87.4 |
| P1898 Pattern Lanfine North Wind | 60996 | 30-Sep-22 | 42 | 5 | 145 | 116.0 |

**Note:**
[a] "Unit Net Generation" refers to gross generating unit output (MW) less unit service load.

*Table 4-7: Dispatch Conditions for Planned Solar Generation Projects*

| Facility Name and Code | Bus No. | Planned ISD | Planning Area No. | AESO Stage | MC (MW) | Unit Net Generations (MW) |
|---|---|---|---|---|---|---|
| | | | | | | 2025 SP |
| P2009 Greengate Travers MPC Solar & P2341 Travers Solar Phase 2 | 560026, 561026, 562026 | Dec 10, 2021& Apr 1, 2022 | 49 | 5 | 465 | 372.0 |
| P1831 Fortis 255S Vulcan Faribault Farms DG PV | 4244 | 44340 | 49 | 5 | 22 | 17.6 |
| P1850 Fortis Coaldale 254S DER Solar 3 | 554691 | May. 24, 2021 | 54 | 5 | 22 | 17.6 |
| P1851 Fortis Monarch 492S DER Solar | 2005 | May. 24, 2021 | 54 | 5 | 23.6 | 18.9 |
| P1862 Fortis Spring Coulee 385S Solar DG | 553246 554246 | Oct. 15, 2021 | 55 | 5 | 29.5 | 23.6 |
| P1870 Fortis Stavely 349S DER Solar | 2004 | 1-Feb-22 | 49 | 5 | 18.5 | 14.8 |
| P1918 FortisAlberta Conrad DER Solar 1 | 554291 | 21-Dec-21 | 52 | 5 | 23.4 | 18.7 |
| P1932 FortisAlberta Namaka DER Solar | 552340 | 3-Sep-21 | 45 | 5 | 20.1 | 16.1 |
| P1959 FortisAlberta Conrad DER Solar 2 | 553291 | 21-Dec-21 | 52 | 5 | 22.5 | 18.0 |
| P2029 FortisAlberta Strathmore 151S DER Solar 1 | 557259 | 8-Nov-21 | 45 | 5 | 19.5 | 15.6 |
| P2030 FortisAlberta Strathmore 151S DER Solar 2 | 558259 | 8-Nov-21 | 45 | 5 | 25 | 20.0 |
| P2195 FortisAlberta Bassano 435S DER Solar | 557399 | 1-Feb-23 | 47 | 3 | 9.25 | 7.4 |
| P2249 FortisAlberta Empress 394S DER Solar 1 | 558316 | 1-Nov-21 | 48 | 5 | 22 | 17.6 |
| P2250 FortisAlberta Empress 394S DER Solar 2 | 558016 | 1-Nov-21 | 48 | 5 | 16 | 12.8 |
| P2300 RESC Enterprise MPC Solar | 563070 | 31-Aug-22 | 49 | 4 | 65 | 52.0 |
| 2335 Fortis Vulcan 255S DER Solar | 990002 | 1-May-22 | 49 | 3 | 13 | 10.4 |
| P2337 Dunmore Solar | 560044 | 1-Apr-23 | 4 | 3 | 216 | 172.8 |

**Note:**

[a] "Unit Net Generation" refers to gross generating unit output (MW) less unit service load.

### 4.2.5 Intertie Flow Assumptions

The intertie flow assumptions for the Alberta-British Columbia (AB-BC), Alberta-Saskatchewan (AB-SK), and Alberta-Montana (MATL) interties are shown in Table 4-8.

For the 2031 WP scenario, the intertie flow values should be set to the AESO planning base cases.

**Table 4-8: Intertie Flows for by Scenario**

| Scenario Number | Scenario Name | Import (-) / Export (+) (MW) by Intertie | | |
|---|---|---|---|---|
| | | AB-BC | AB-SK | MATL |
| 1A, 1B, 3A, 3B | 2025 SP | -516 | 0 | 0 |
| 2A, 4A | 2025 WP | -460 | 0 | 0 |

### 4.2.6 HVDC Power Order Assumptions

The Western Alberta Transmission Line (WATL) and the Eastern Alberta Transmission Line (EATL) are high-voltage direct current (HVDC) transmission lines. The HVDC power order assumptions for the studies will be set to minimize losses for the pre-Project and post-Project study scenarios.

For the 2031 WP scenario, the HVDC power order should be as per the AESO base cases and will not be adjusted.

**Table 4-9: HVDC Power Order by Scenario**

| Scenario Number | Scenario Name | WATL (MW)* | EATL (MW)* |
|---|---|---|---|
| 1A | 2025 SP | 100.0 N -> S | 100.0 S -> N |
| 2A | 2025 WP | 450.0 N -> S | 100.0 S -> N |
| 1B | 2025 SP | 250.0 S -> N | 1000.0 S -> N |
| 3A | 2025 SP | 100.0 N -> S | 100.0 S -> N |
| 4A | 2025 WP | 450.0 N -> S | 100.0 S -> N |
| 3B | 2025 SP | 250.0 S -> N | 1000.0 S -> N |

**Notes:**
*N → S: HVDC flow direction is North to South*
*S → N: HVDC flow direction is South to North*

The reactive power limits of the MVAr exchanges between the HVDC terminals (WATL and EATL) and the connected alternating current (AC) transmission systems are shown in Table 4-10. These limits must be maintained when performing the studies.

***Table 4-10: HVDC to Adjacent AC System MVAr Exchange Limits***

| HVDC Facility | North Terminal Reactive Power Limit (MVAr) | South Terminal Reactive Power Limit (MVAr) |
|---|---|---|
| EATL | -85 to 75 | -35 to 35 |
| WATL | -75 to 75 | -35 to 35 |

### *4.2.7 Transmission Facility Ratings*

The legal owners of transmission facilities (TFOs) provided the thermal ratings assumptions for the existing transmission lines in the Study Area. Table 4-11 shows the normal ratings and emergency ratings for the key transmission lines in the Study Area, which will be used to perform the engineering studies.

***Table 4-11: Thermal Rating Assumptions for Key Transmission Lines in the Study Area***

| Line ID | Line Description | Voltage Class (kV) | Normal Rating (MVA) | | Emergency Rating (MVA) | |
|---|---|---|---|---|---|---|
| | | | Summer | Winter | Summer | Winter |
| 1064L | Janet 74S - Langdon 102S | 240 | 974 | 1039 M | 1039 M | 1039 M |
| 1065L | Janet 74S - Langdon 102S | 240 | 974 | 1208 | 1169 | 1247 M |
| 985L | Janet 74S - Shepard SS-25 | 240 | 973 | 1039 M | 1017 | 1039 M |
| 1003L | Janet 74S - Shepard SS-25 | 240 | 973 | 1039 M | 1017 | 1039 M |
| 932L | Janet 74S - Beddington SS-162 | 240 | 481 | 581 | 577 | 648 M |
| 929L | Janet 74S - Hazelwood 287S | 240 | 441 LTD-L | 581 | 529 LTD-L | 648 M |
| 925L | Janet 74S - Red Deer 63S | 240 | 476 M | 571 M | 524 M | 619 M |
| 901L | Janet 74S - Red Deer 63S | 240 | 408 | 494 | 490 | 593 |
| 765L | Janet 74S - Strathmore 151S | 138 | 85 | 90 | 94 | 99 |
| 23.80L | Janet 74S - SS-23 | 138 | 285 | 287 | 285 | 350 |
| 2.80L | SS-2 - SS-23 | 138 | 285 | 350 | 285 | 350 |
| 9.80L | SS-9 - SS-31 | 138 | 287 | 287 | 316 | 316 |
| 24.81L | SS-24 - SS-31 | 138 | 287 | 287 | 316 | 316 |
| 24.82L | SS-24 - SS-65 | 138 | 285 | 350 | 285 | 350 |
| 24.83L | Janet 74S - SS-24 | 138 | 322 | 408 | 354 | 430 |
| 37.82L | Janet 74S - SS-37 | 138 | 287 | 287 | 352 | 430 |
| 37.81L | SS-37 - SS-38 | 138 | 287 | 287 | 316 | 316 |
| 38.83L | SS-38 - SS-39 | 138 | 287 | 287 | 316 | 316 |
| 22.81L | SS-22 - SS-39 | 138 | 285 | 287 | 285 | 316 |
| 13.82L | SS-13 - SS-22 | 138 | 161 | 204 | 177 | 225 |

| Line ID | Line Description | Voltage Class (kV) | Normal Rating (MVA) | | Emergency Rating (MVA) | |
|---|---|---|---|---|---|---|
| | | | Summer | Winter | Summer | Winter |
| 39.82L | SS-39 - SS-162 | 138 | 322 | 408 | 354 | 449 |
| 2.83L | SS-5 – 2.83 Tap point | 138 | 322 | 408 | 354 | 449 |
| 2.83L | SS-13 – 2.83 Tap point | 138 | 287 | 287 | 316 | 316 |
| 2.83L | SS-2 – 2.83 Tap point | 138 | 338 | 343 | 342 | 343 |
| 2.82L | SS-2 - SS-5 | 138 | 322 | 328 | 327 | 328 |
| 11.81L | SS-11 - SS-13 | 138 | 287 | 287 | 316 | 316 |
| 11.83L | SS-11 - SS-162 | 138 | 330 | 398 | 330 | 398 |
| 26.83L | SS-26 - SS-65 | 138 | 285 | 350 | 285 | 350 |
| 26.81L | SS-26 - SS-32 | 138 | 285 | 287 | 285 | 316 |
| 31.84L | SS-31 - SS-32 | 138 | 161 | 191 | 177 | 210 |
| 2.81L | SS-2 - SS-9 | 138 | 287 | 287 | 316 | 316 |

**Note:**
"M" indicates that the transmission line rating is limited for reasons other than protection equipment, transformer, current transformer, line, ganged switch, circuit breaker, or regulator.

"LTD-L" indicates that the transmission line rating is long-term derated from LiDAR surveys

The TFOs provided the details of the substation transformers in the Study Area. The key transformers in the Study Area are shown in Table 4-12.

*Table 4-12: Summary of Key Transformer Ratings in the Study Area*

| Substation Name and Number | Transformer ID | Transformer Voltages* (kV) | Transformer Rating (MVA) |
|---|---|---|---|
| Janet 74S | 74ST1 | 240/138 | 341.8 (Summer)<br>400.0 (Winter) |
| | 74ST2 | 240/138 | 341.8 (Summer)<br>400.0 (Winter) |
| SS-162 | 162.1TR | 240/138 | 400 |
| | 162.2TR | 240/138 | 400 |
| East Calgary 5S | 5ST1 | 240/138 | 400 |
| | 5ST2 | 240/138 | 400 |
| SS-38 | 38.1TR | 138/13.8 | 30 |
| | 38.2TR | 138/13.8 | 30 |
| | 38.3TR | 138/13.8 | 30 |
| SS-37 | 37.1TR | 138/13.8 | 50 |
| | 37.2TR | 138/13.8 | 50 |
| SS-24 | 24.1TR | 138/25 | 50 |
| | 24.2TR | 138/25 | 50 |

* System nominal voltage. May differ from rated bushing voltage.

The TFOs provided the details of the shunt elements in the Study Area. The key shunt elements in the Study Area are shown in Table 4-13.

***Table 4-13: Summary of Key Shunt Elements in the Study Area***

| Substation Name and Number | Voltage Class (kV) | Capacitors | |
|---|---|---|---|
| | | Number of Switched Shunt Blocks | Total at Nominal Voltage (MVAr) |
| Janet 74S | 240 | 2 | 268.8 |
| | 138 | 2 | 146.74 |
| Sarcee 42S | 240 | 2 | 201.6 |
| | 138 | 1 | 48.92 |
| Langdon 102S | 240 | SVC (Continuous) | +216.28 to -296.2 |
| SS-2 | 138 | 2 | 160.00 |
| SS-14 | 138 | 2 | 48.91 |
| SS-21 | 138 | 1 | 48.91 |
| SS-31 | 138 | 1 | 48.11 |
| SS-38 | 138 | 1 | 48.11 |
| SS-41 | 138 | 1 | 53.96 |

### 4.2.8 Voltage Profile Assumption

ID #2010-007RS will be used to establish system normal (i.e., pre-contingency) voltage profiles for key area busses prior to commencing any studies. Table 2-1 of the *Transmission Planning Criteria – Basis and Assumptions* applies for the busses not included in ID #2010-007RS. These voltages will be used to set the voltage profile for the study base cases prior to the power flow studies.

# 5 Study Methodology

The studies to be performed for this connection assessment are identified in Table 5-1.

***Table 5-1: Summary of the Studies to be Performed***

| Scenario No. and Name | | Power Flow | | Voltage Stability | | Transient Stability | | Motor Starting | | Short Circuit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Category | | Category | | Category | | Category | | Category A |
| | | A | B | A | B | A | B | A | B | |
| **Pre-Project** | | | | | | | | | | |
| 1A | 2025 SP | X | X | | | | | | | |
| 2A | 2025 WP | X | X | | | | | | | X |
| 1B | 2025 SP | X | X | | | | | | | |
| **Post-Project** | | | | | | | | | | |
| 3A | 2025 SP | X | X | X | X | | | | | |
| 4A | 2025 WP | X | X | X | X | | | | | X |
| 3B | 2025 SP | X | X | | | | | | | |
| 5 | 2031 WP | | | | | | | | | X |

For the engineering studies, all transmission facilities 69 kV and above, within the Study Area and the transmission lines connecting this planning area to neighbouring planning areas will be studied and monitored to assess the impact of the Project on the performance of the AIES, including any violations of the Reliability Criteria (as defined in Section 3.1).

## 5.1 Power Flow Studies

Power flow studies will be performed to identify thermal and voltage criteria violations as per the Reliability Criteria, and any deviations from the limits listed in Table 3-1.

For information purposes, the Studies Consultant must also provide, as a separate file, a list of any transmission elements where the thermal loading exceeds 95% of the element's normal rating under Category A and Category B conditions.

For the Category B power flow studies, the transformer taps and switched shunt reactive compensating devices such as shunt capacitors and reactors will be locked and continuous shunt devices will be enabled.

Voltage deviations at point-of-delivery (POD) low voltage busses will also be assessed for both the pre-Project and post-Project networks by first locking all tap changers and area shunt reactive compensating devices to identify any post-transient voltage deviations above 10%. Second, tap changers will be allowed to move while shunt reactive compensating devices remained locked to determine if any voltage deviations above 7% would occur in the area. Third, all the taps and shunt reactive compensating devices will be allowed to adjust, and voltage deviations above 5% will be reported.

The scenarios to be studied are shown in Table 5-1.

### *5.1.1 Contingencies to be Studied*

Power flow studies will be performed for the Category A and all Category B conditions in the Study Area.

## 5.2 Voltage Stability Studies

The objective of the voltage stability studies is to determine the ability of the transmission system to maintain voltage stability margin at all busses under Category A and Category B conditions. The power-voltage (PV) curve is a representation of voltage change as a result of increased power transfer between two systems. The incremental transfers will be reported at the collapse point.

Voltage stability studies will be performed for the post-Project scenarios. For load connection projects, the load level modeled in post-Project scenarios is the same as, or higher than, in pre-Project scenarios. Therefore, voltage stability studies for pre-Project scenarios will only be performed if post-Project scenarios show voltage stability criteria violations.

Voltage stability studies will be performed according to the Western Electricity Coordinating Council (WECC) Voltage Stability Assessment Methodology. WECC voltage stability criteria states, for load areas, post-transient voltage stability margin is required for the area modeled at a minimum of 105% of the reference load level for Category A conditions and for Category B conditions. For this standard, the reference load level is the maximum established planned load.

Typically, voltage stability studies are carried out assuming the worst case scenarios in terms of loading. In this connection assessment, the voltage stability studies will be performed by increasing load in Calgary Area (Area 6) and increasing generation in Wabamun (Area 40) and Fort McMurray (Area 25).

The scenarios and cases to be studied are shown in Table 5-1.

### *5.2.1 Contingencies to be Studied*

Voltage stability studies will be performed for all Category B contingencies in the Study Area. The Category A condition and the five contingencies with the smallest stability margin will be presented in the results.

## 5.3 Short-Circuit Current Level Studies

A maximum fault level must be provided for the substations in the vicinity of the Project assuming normal system operation with all transmission elements in service and generation dispatched. Three-phase faults and single line-to-ground faults will be simulated. Polar coordinates and per-unit values will be used for reporting the results.

Winter peak scenarios will be used for the short-circuit studies because winter peak scenarios generally produce higher short-circuit current levels than summer peak scenarios.

Estimated maximum three-phase faults and single line-to-ground short-circuit current levels will be reported for the following substations:

- Janet 74S
- SS-37
- SS-38
- SS-23
- SS-24
- SS-39

Further sensitivity studies, in consultation with the TFO, may be required if the primary short-circuit analysis indicates a potential to exceed or approach the existing fault rating of the transmission facilities.

The scenarios to be studied are as shown in Table 5-1.

# 6 Mitigation Measures

## 6.1 Development

Mitigation measures may be required if the post-Project study results identify system performance issues. Mitigation measures for the Project may involve modifying or adding real-time operational practices and/or remedial action schemes (RASs).

The Studies Consultant must notify the AESO of any system performance issues in a timely manner, following which the AESO Studies Engineer may instruct the Studies Consultant as follows:

- Develop tables showing the constraint effective factors[3] for generation or load based on thermal criteria violations that are observed.
- Collaborate with the AESO to propose changes, if any, to the connection alternatives that could remove the requirement for a RAS.
- Collaborate with the AESO to study modifications to existing and/or planned RASs, proposed by the AESO, to ensure the coordination of existing protection schemes with the addition of any proposed protection schemes.
- Collaborate with the AESO to identify and study new RASs, if any, that may be required to ensure system reliability is maintained after connecting the Project to the AIES.

The AESO Studies Engineer will work closely with the Studies Consultant and guide the development and/or modifications of the proposed mitigation measures to ensure system reliability, security and compliance with AESO ID #2018-018T, *Provision of System Access Service and the Connection Process*.

## 6.2 Evaluation

### *6.2.1 Post-Mitigation Studies*

Studies to evaluate the effectiveness of mitigation measures, if required, will be performed in accordance with the technical criteria, assumptions, and methods provided in this Study Scope and in accordance with further instructions from the AESO.

### *6.2.2 Constraint Effective Factor Studies*

Constraint effective factor analysis are used to determine the generator- and load- constraint effective factors and to identify the most effective generators or loads to manage the thermal criteria violations, if any, that are observed under Category B conditions.

[3] Constraint effective factor studies are performed to determine the generator- and load- constraint effective factors. Constraint effective factors are used to estimate the ability of generators and loads to manage transmission constraints. A generator's or load's constraint effective factor is defined as the change in power flow over a specific transmission line following a change in the generator's energy production or in the load's energy consumption. The greater the constraint effective factor, the more effective a generator or load can be in managing a thermal criteria violation on the specific transmission line.

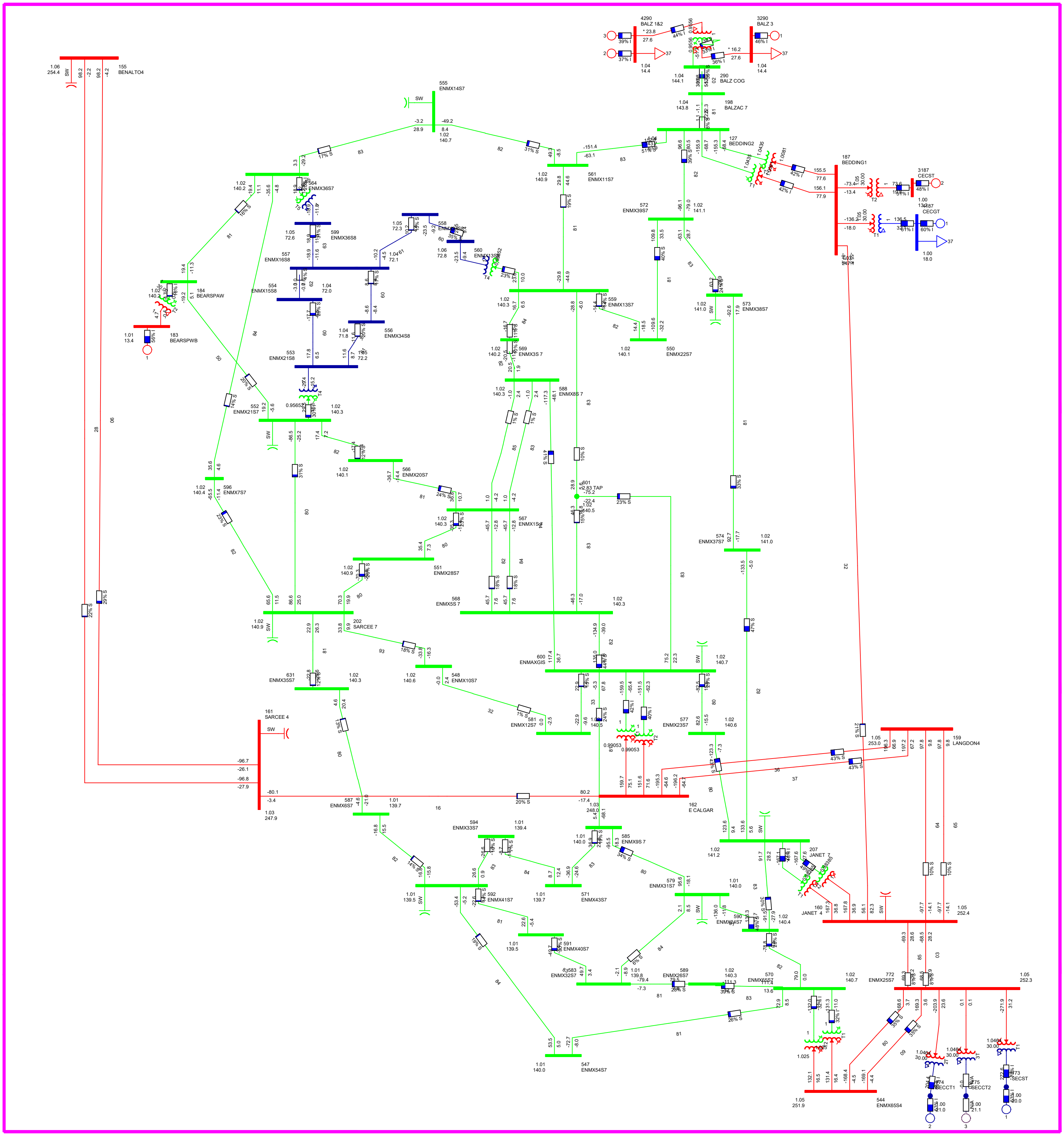
# 7 Changes to Study Assumptions

This study will utilize the AESO's planning base cases, which are based on the AESO's current corporate forecast (2021 LTO) with modifications to incorporate the latest forecast intelligence. Sensitivity studies or restudy may be required in the event of revisions to the AESO's corporate forecast, forecast intelligence, or other study assumptions. Additional engineering studies may also be required to assess new connection alternatives, changes to project ISD, or delays in proposed system developments. Any additional or revised study requirements shall be captured in a signed Study Scope Amendment document.

# Attachment A:
# Transmission Planning Criteria – Basis and Assumptions

# Attachment A2
# Pre-Project Power Flow Diagrams

# Cat A: 2025_SP_Pre-Project_A



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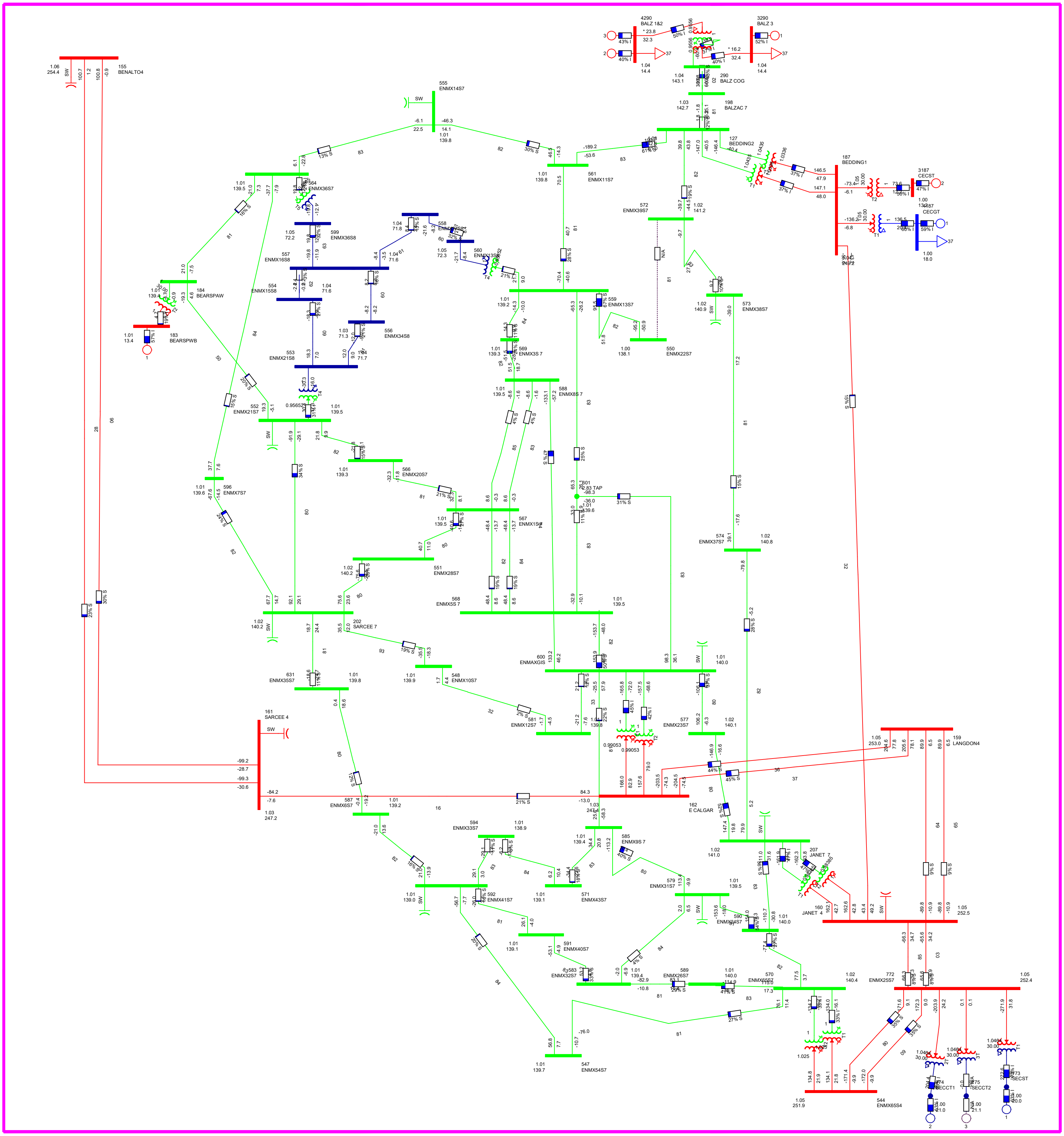

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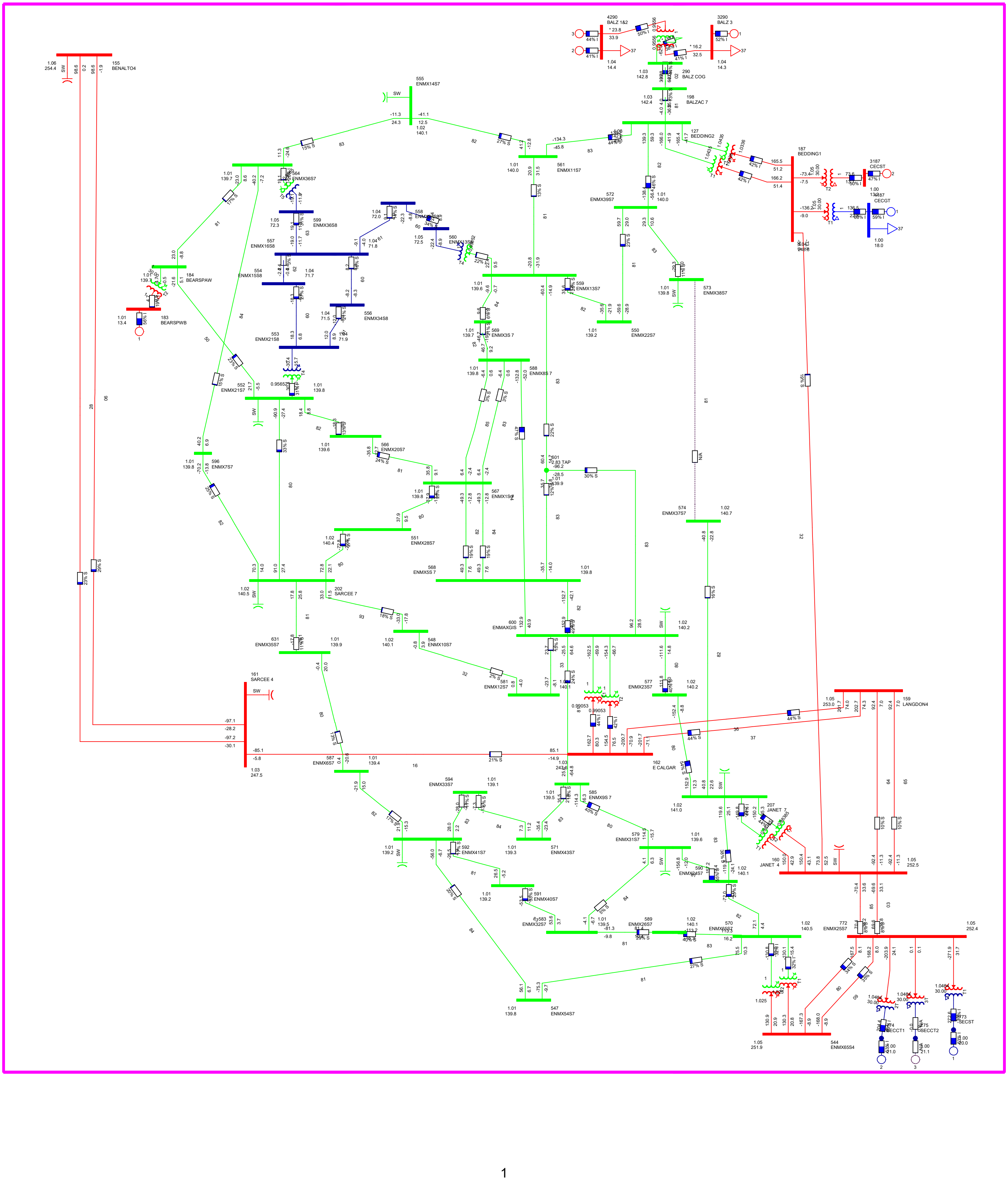

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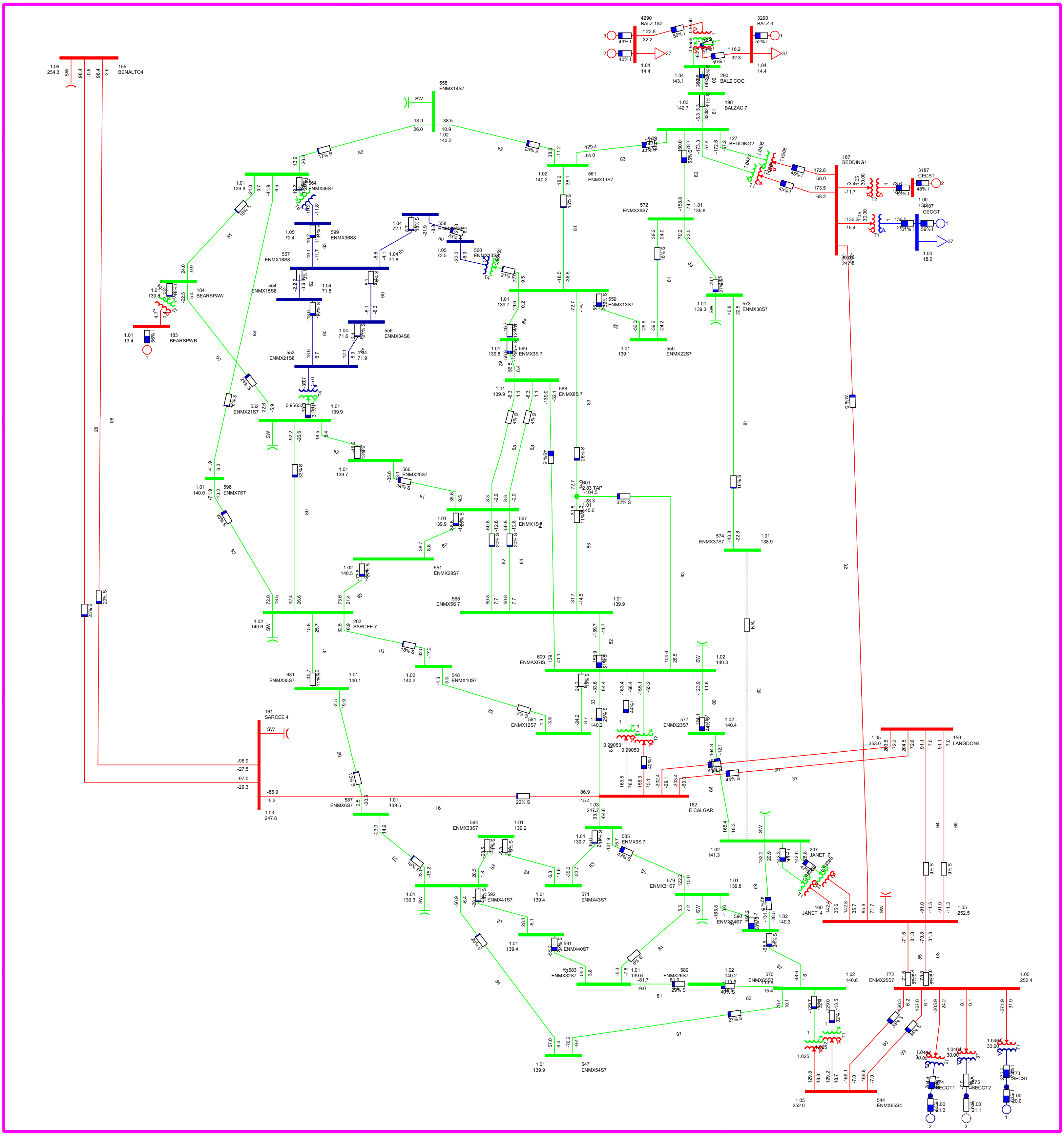

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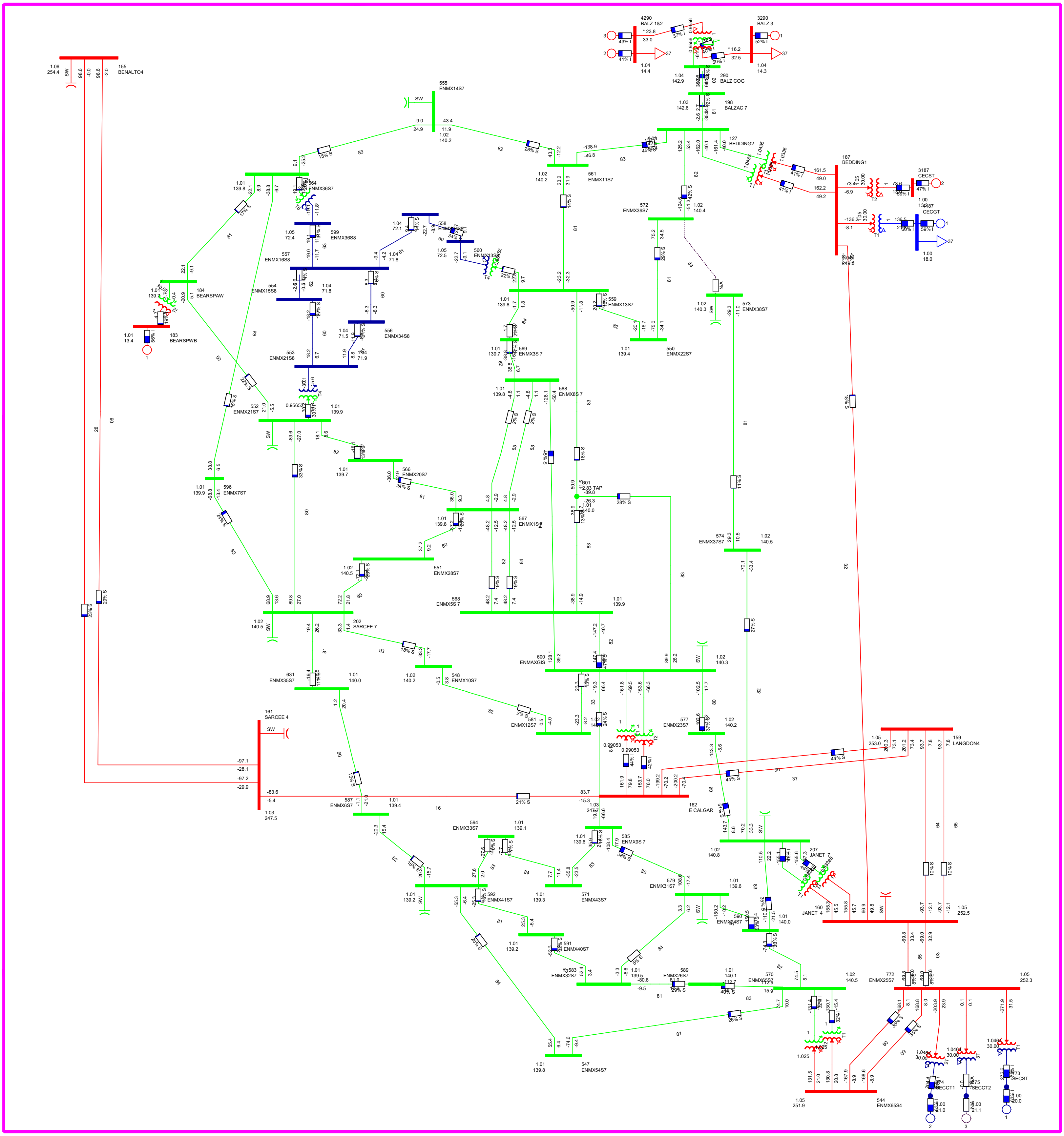

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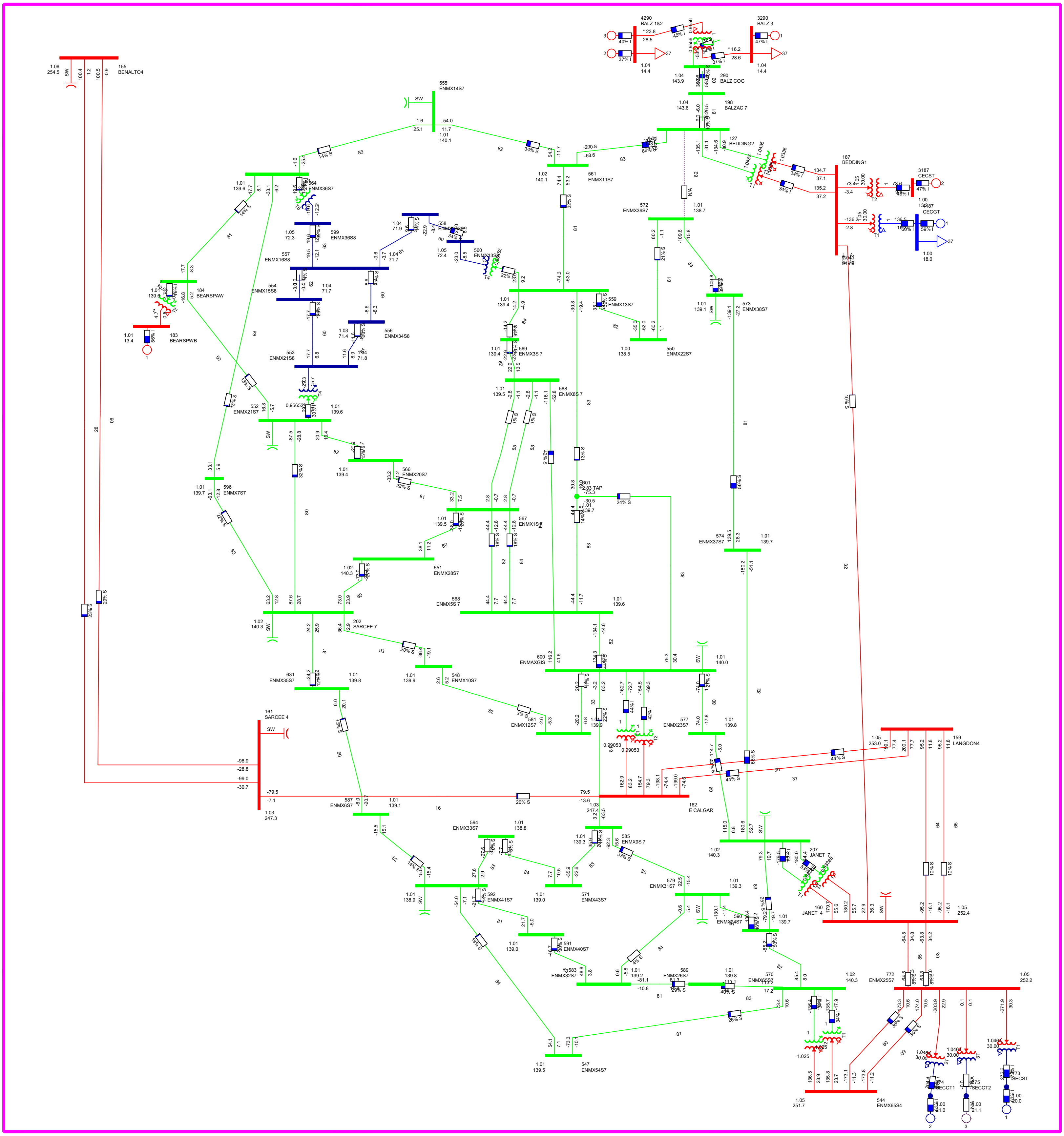

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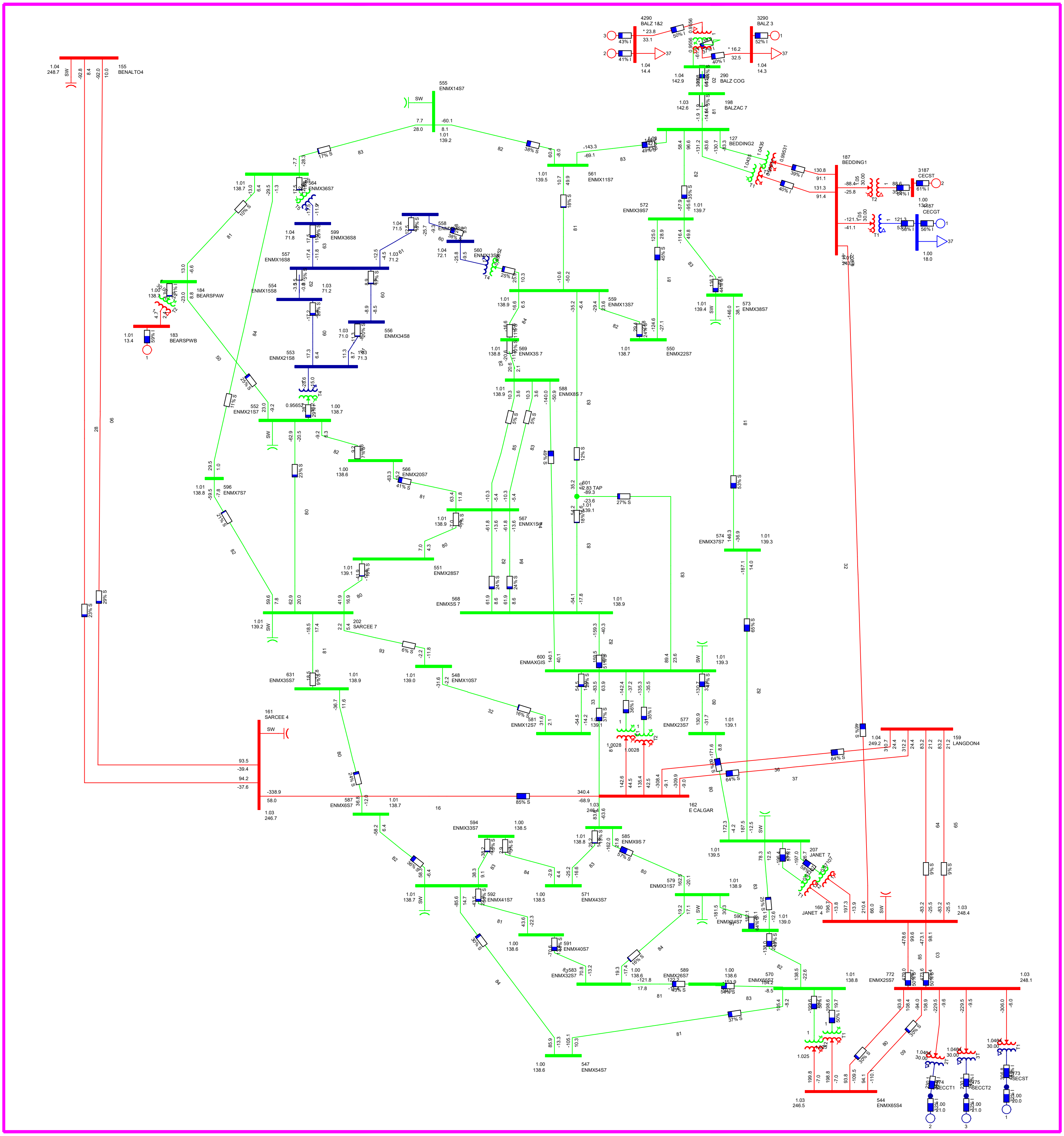

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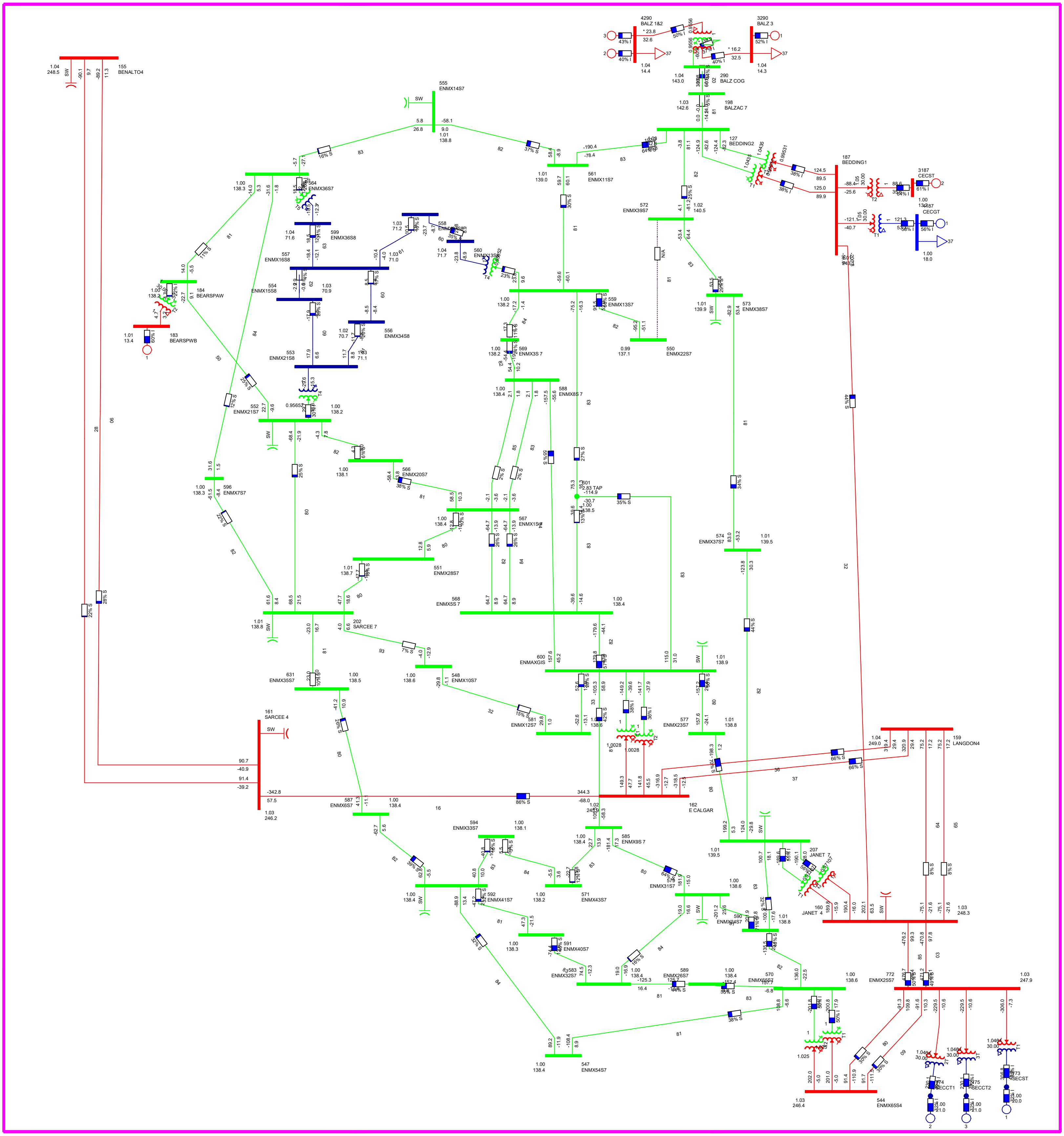

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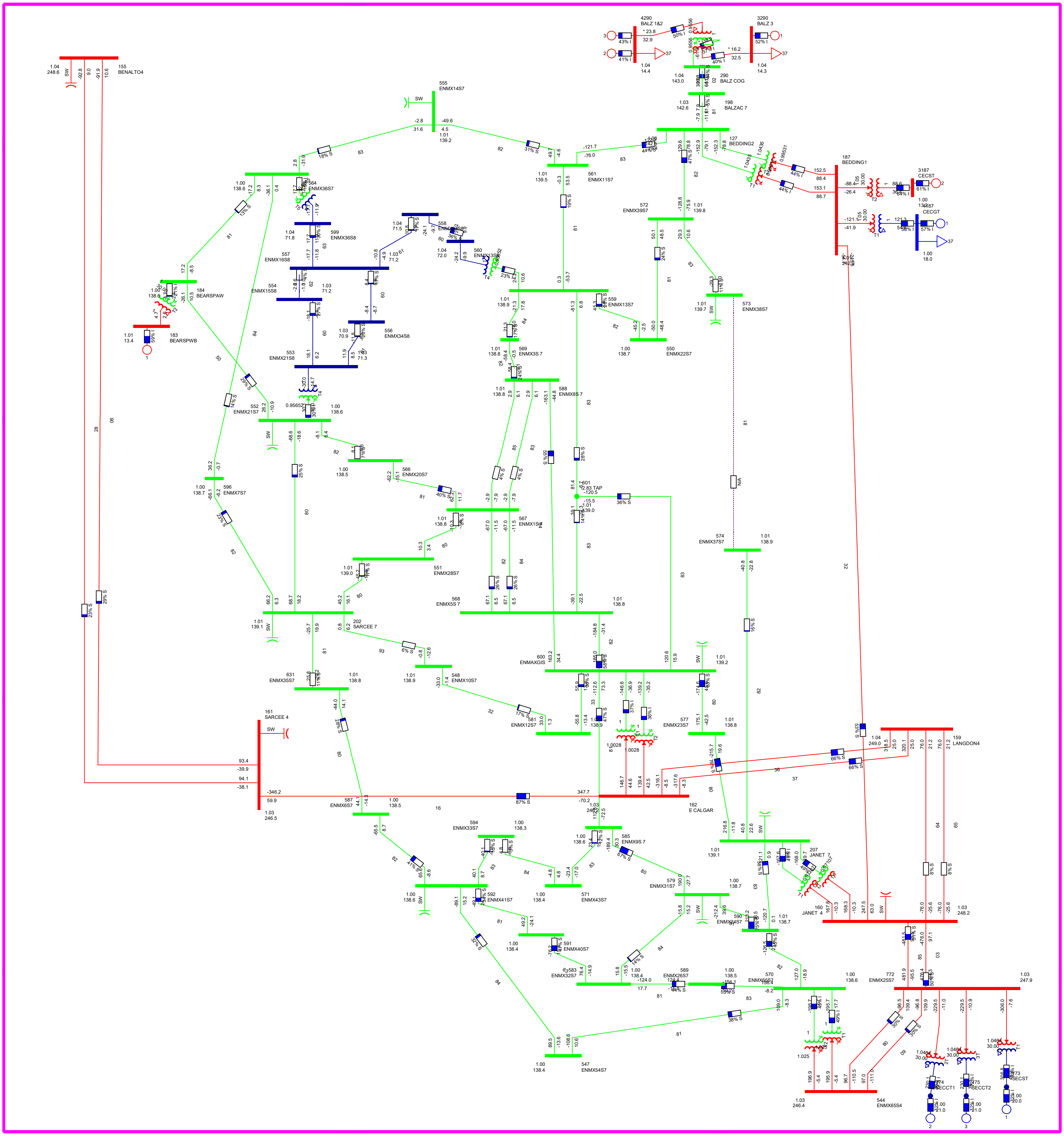

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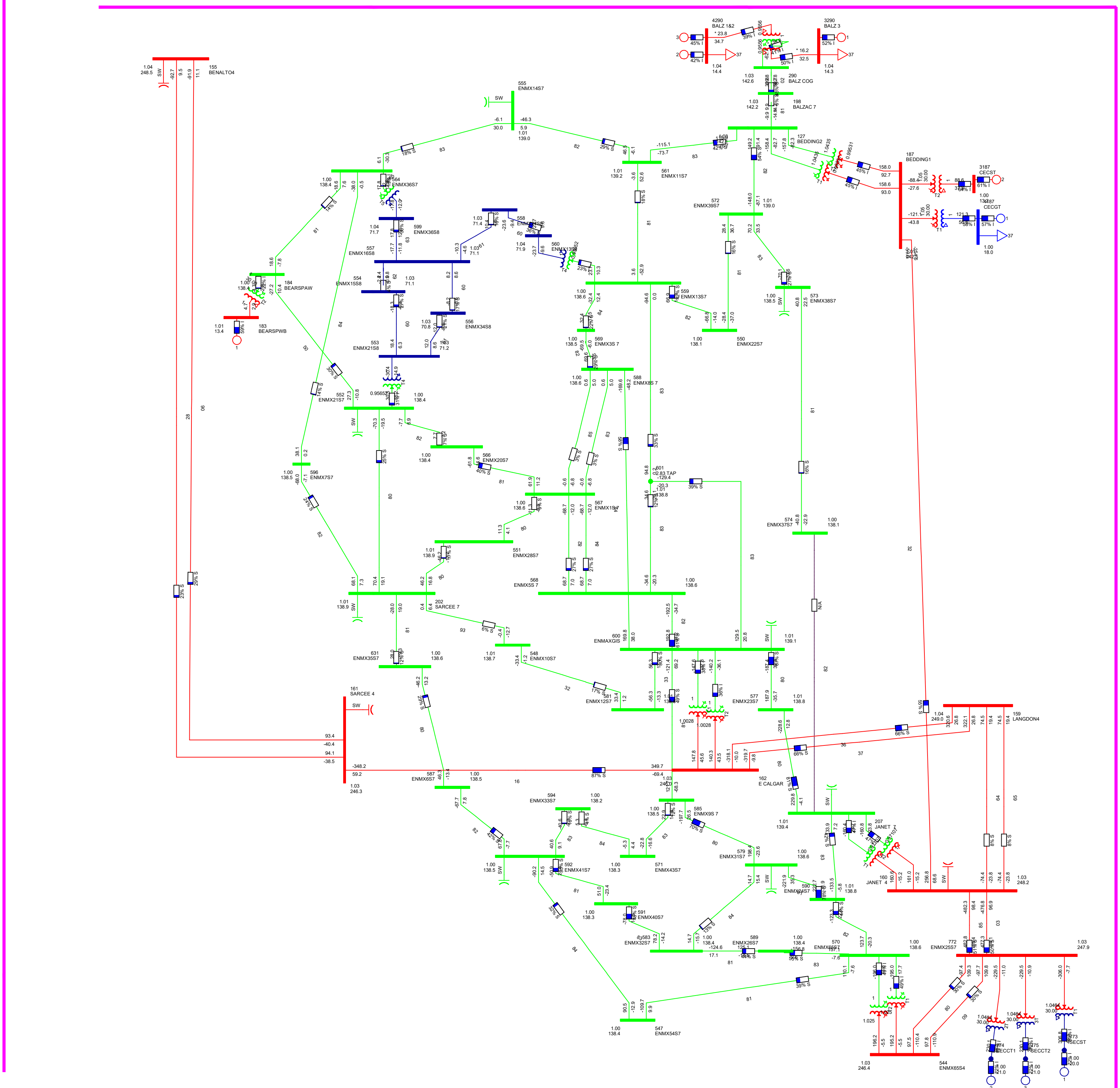

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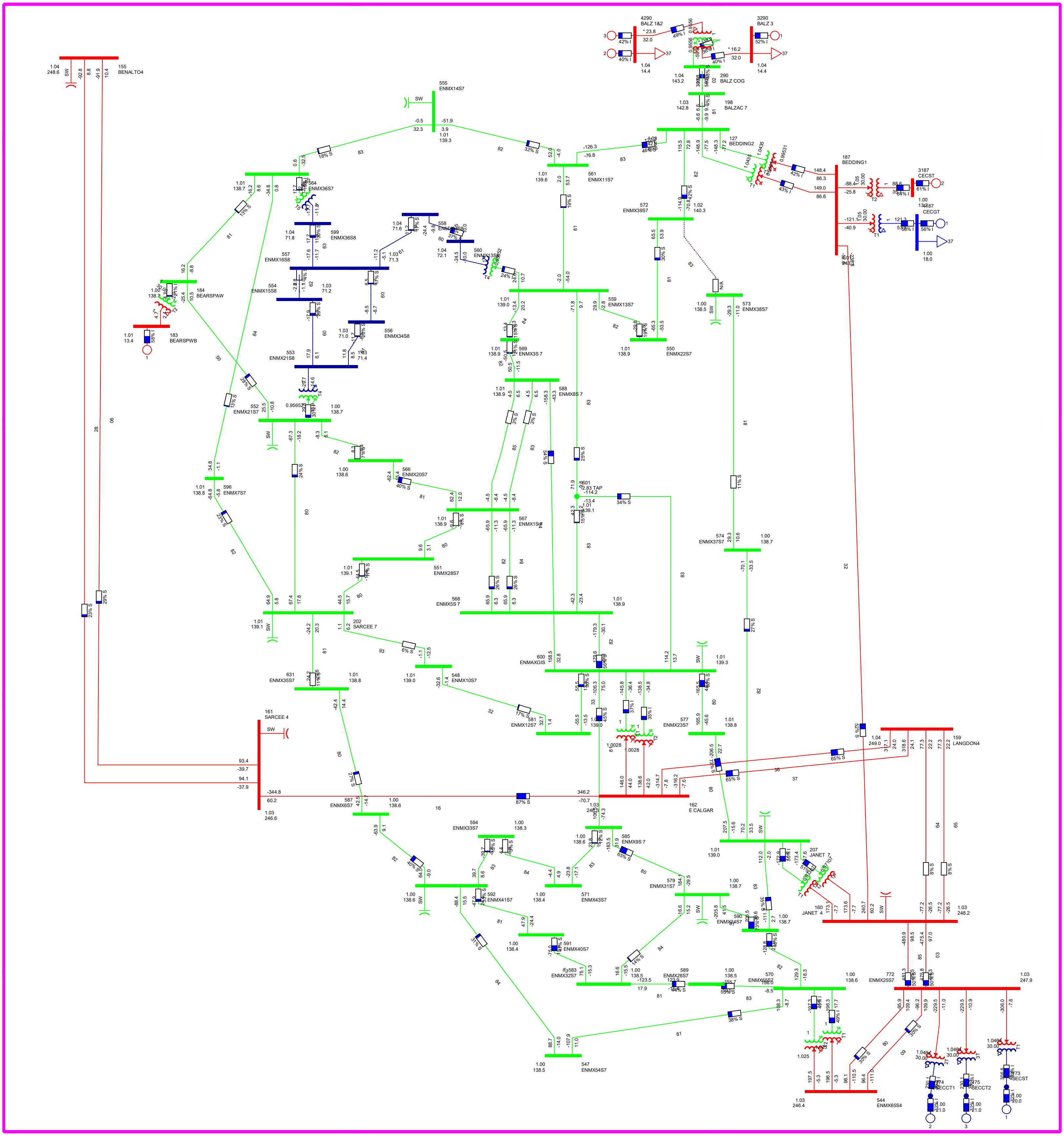

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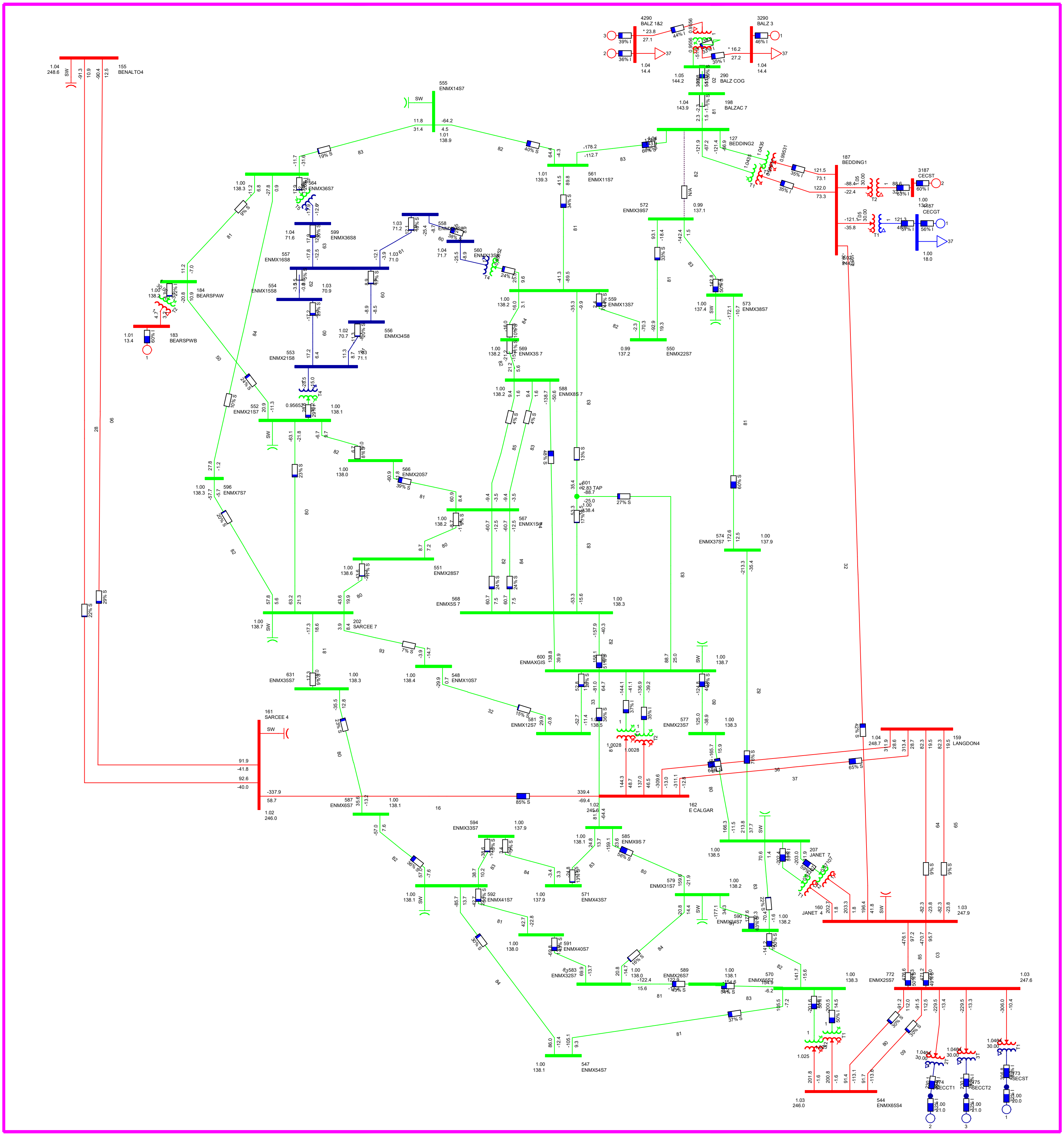

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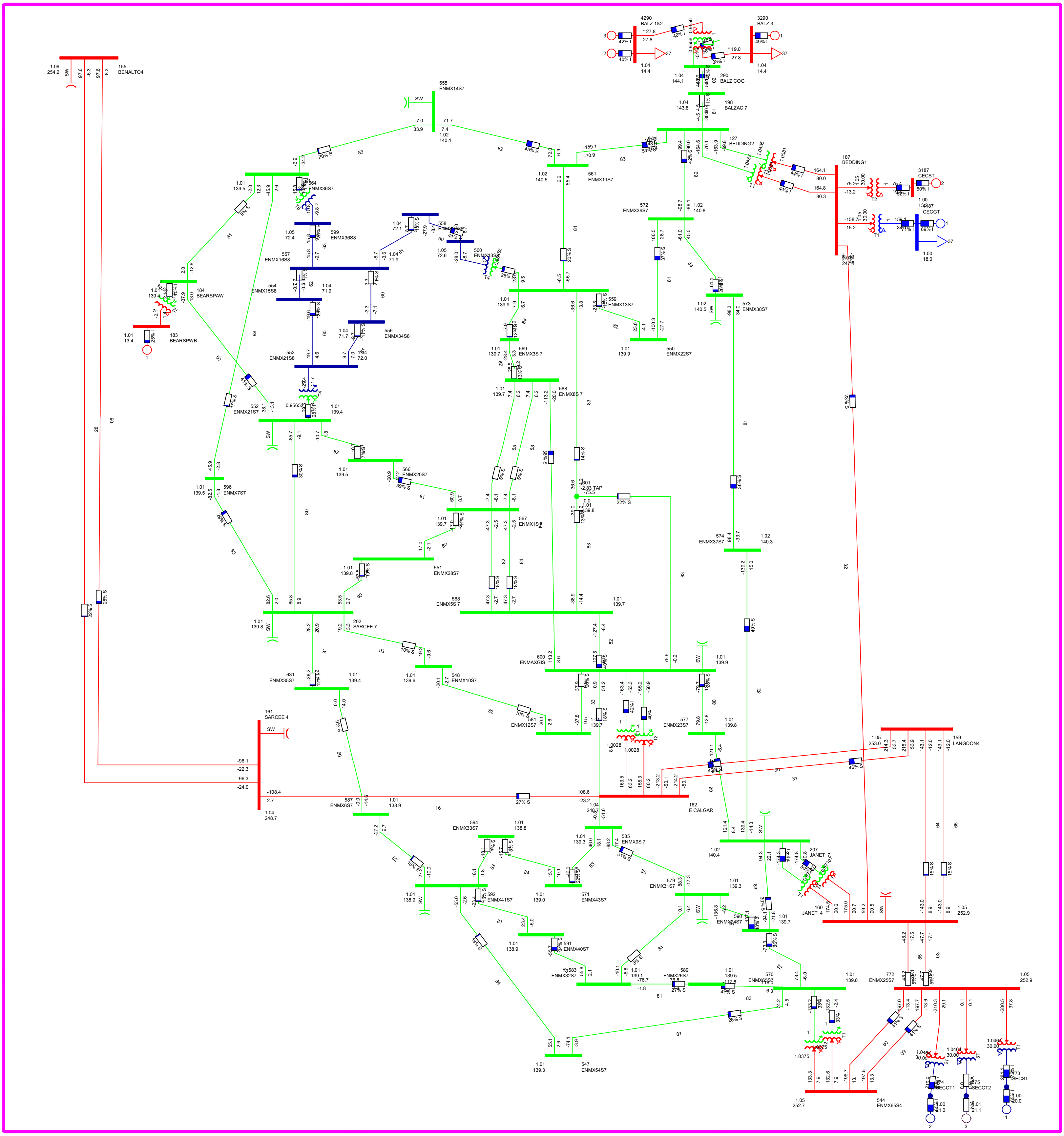

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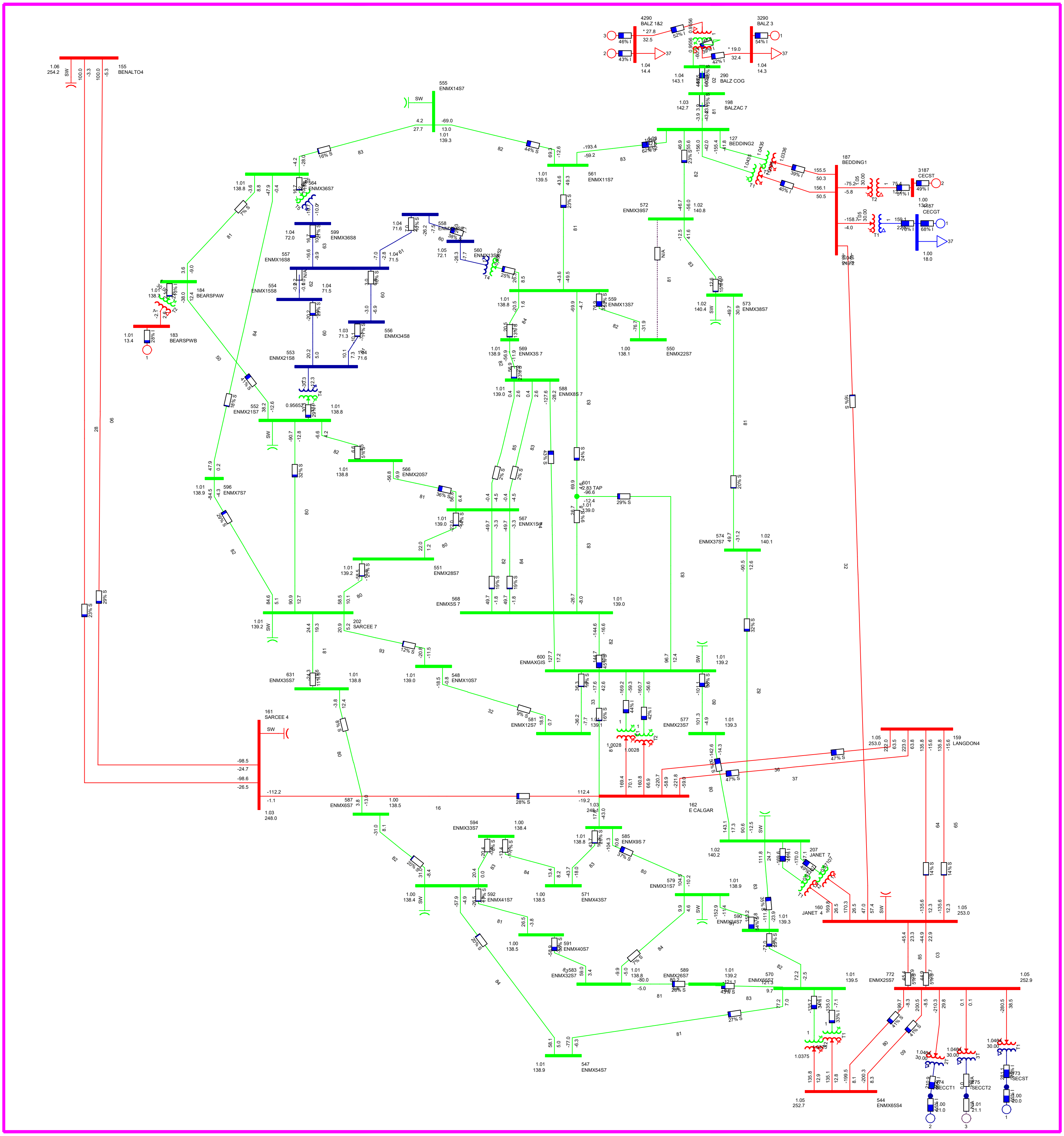

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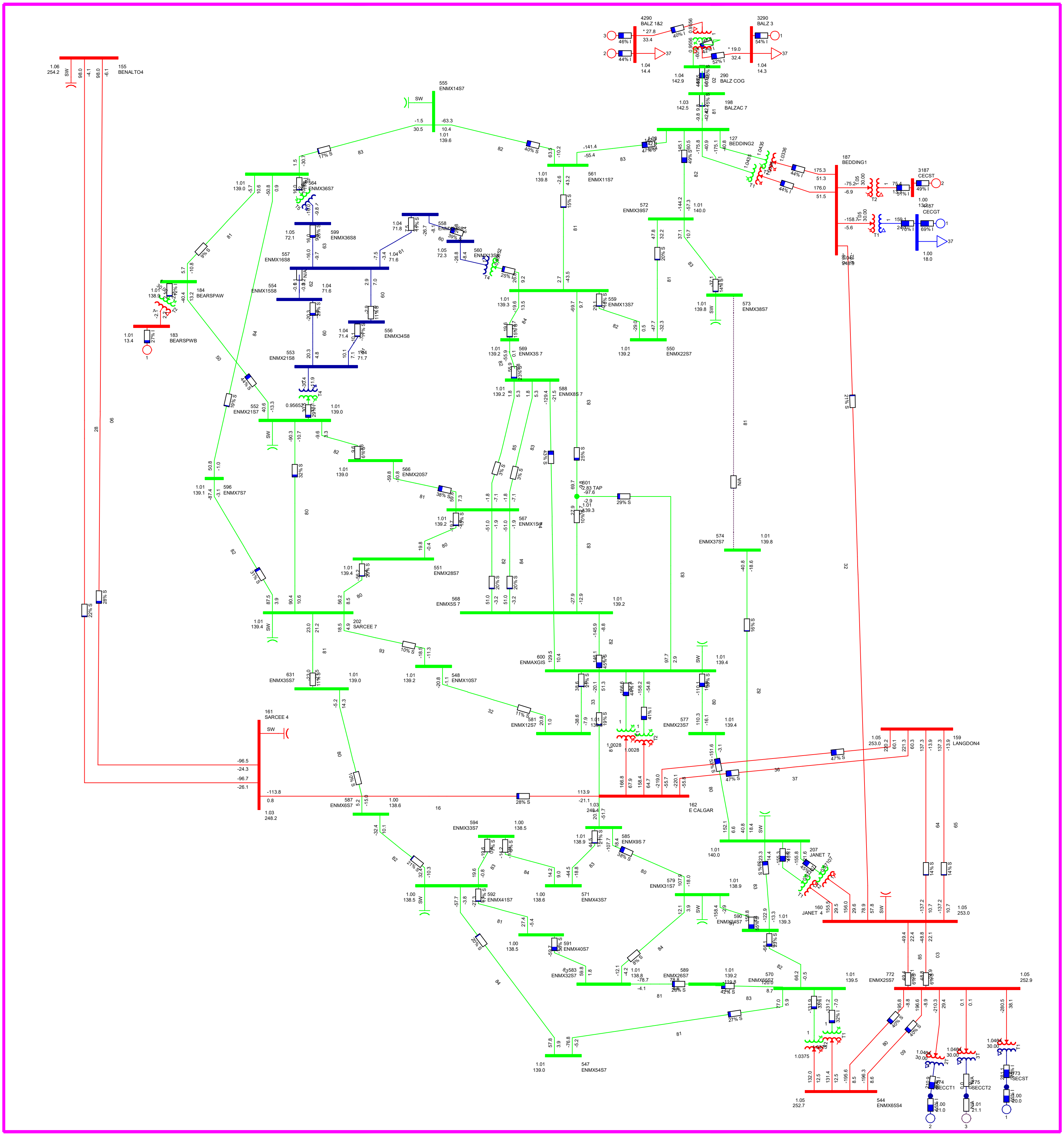

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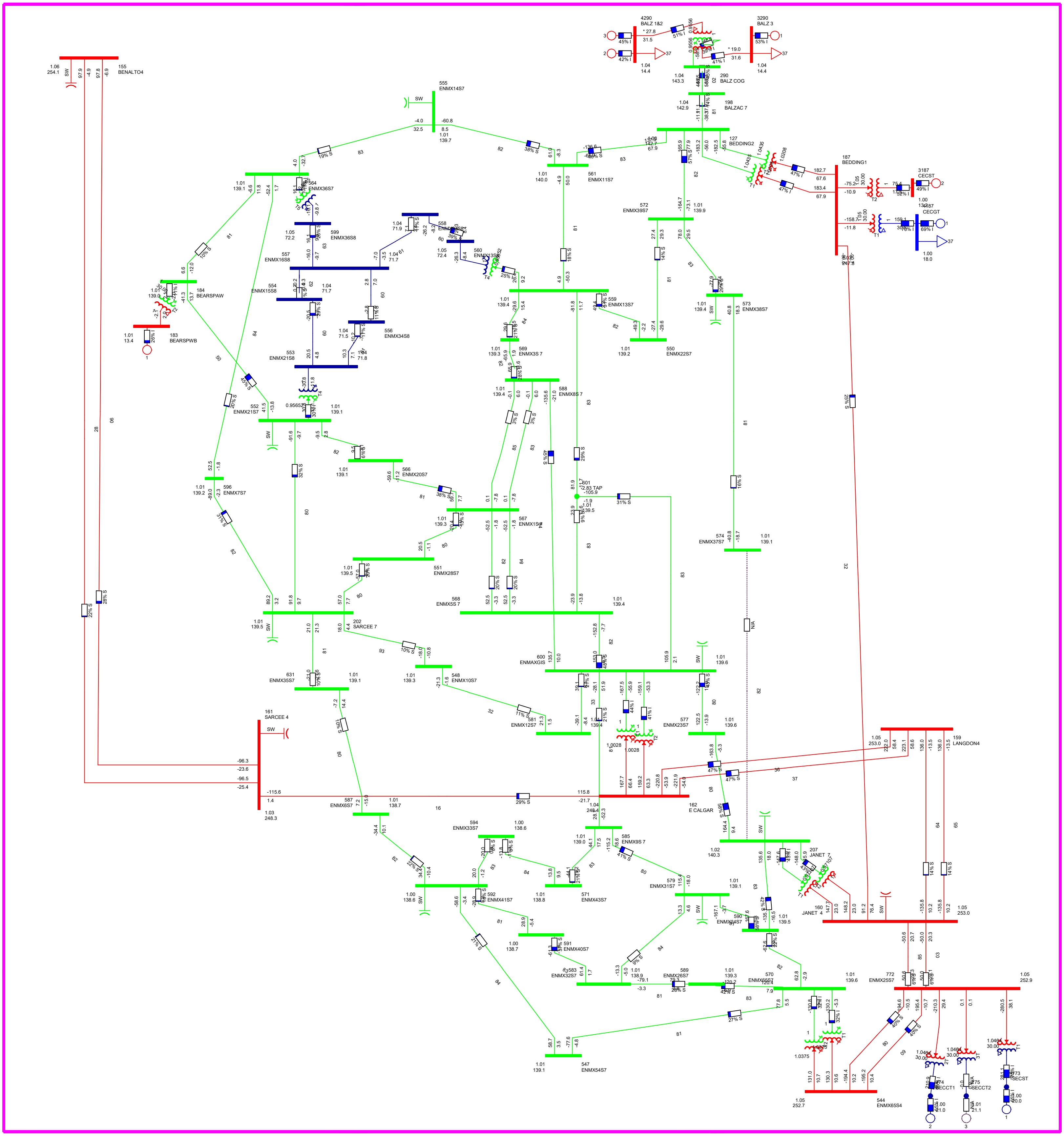

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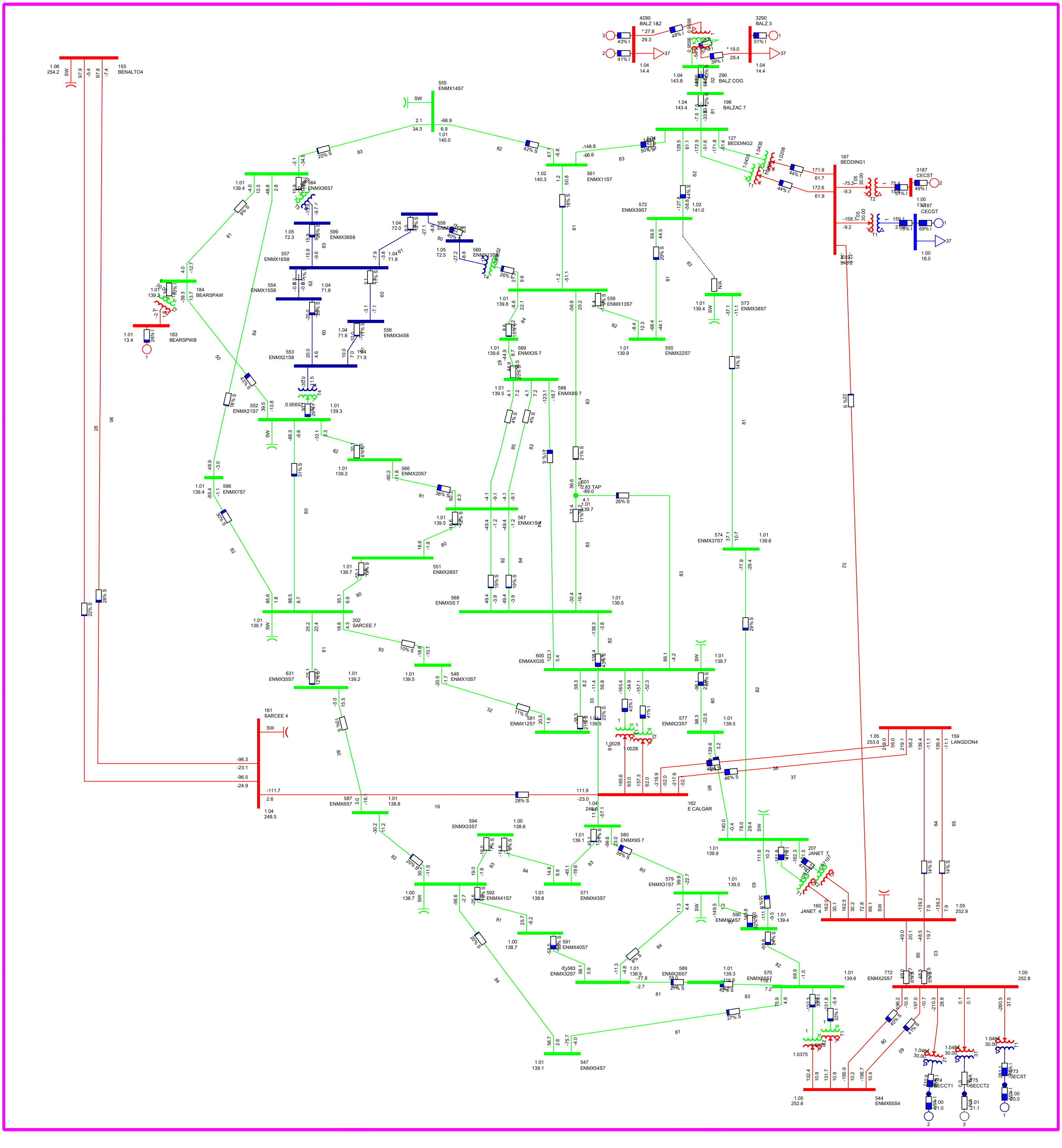

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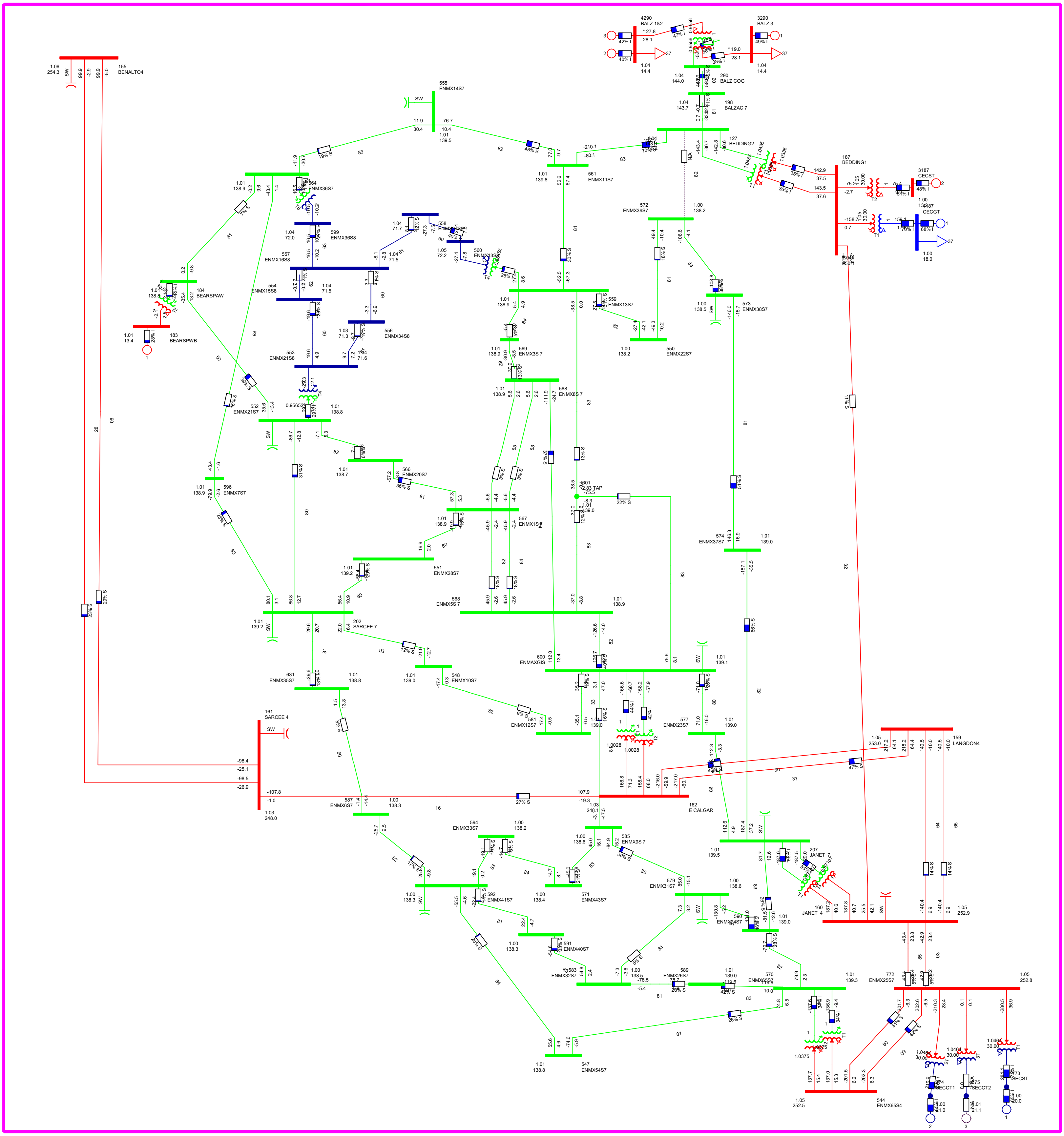
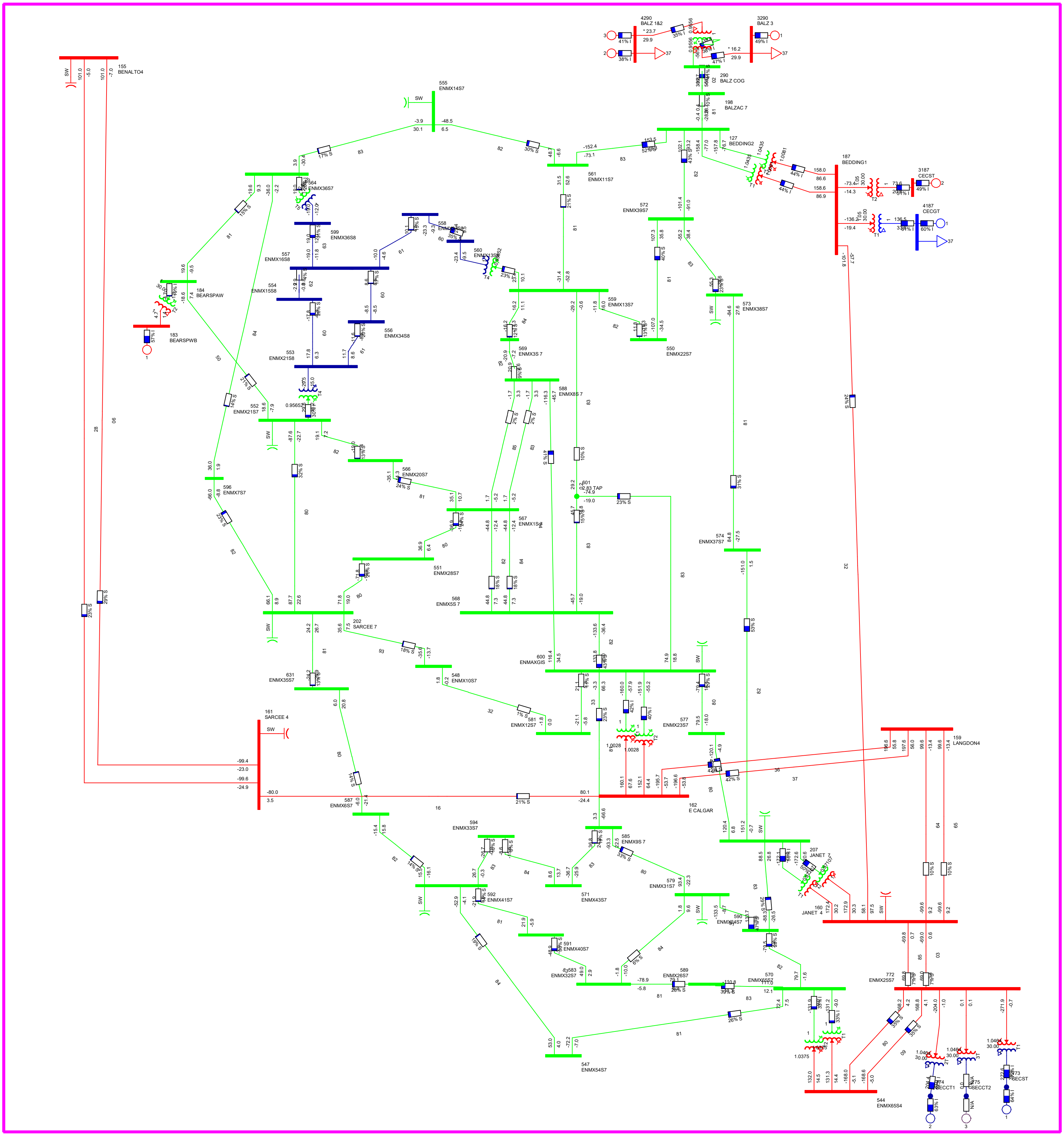


# Attachment A3
# Post-Project Power Flow Diagrams

# Cat A: 2025_SP_Post-Project_A



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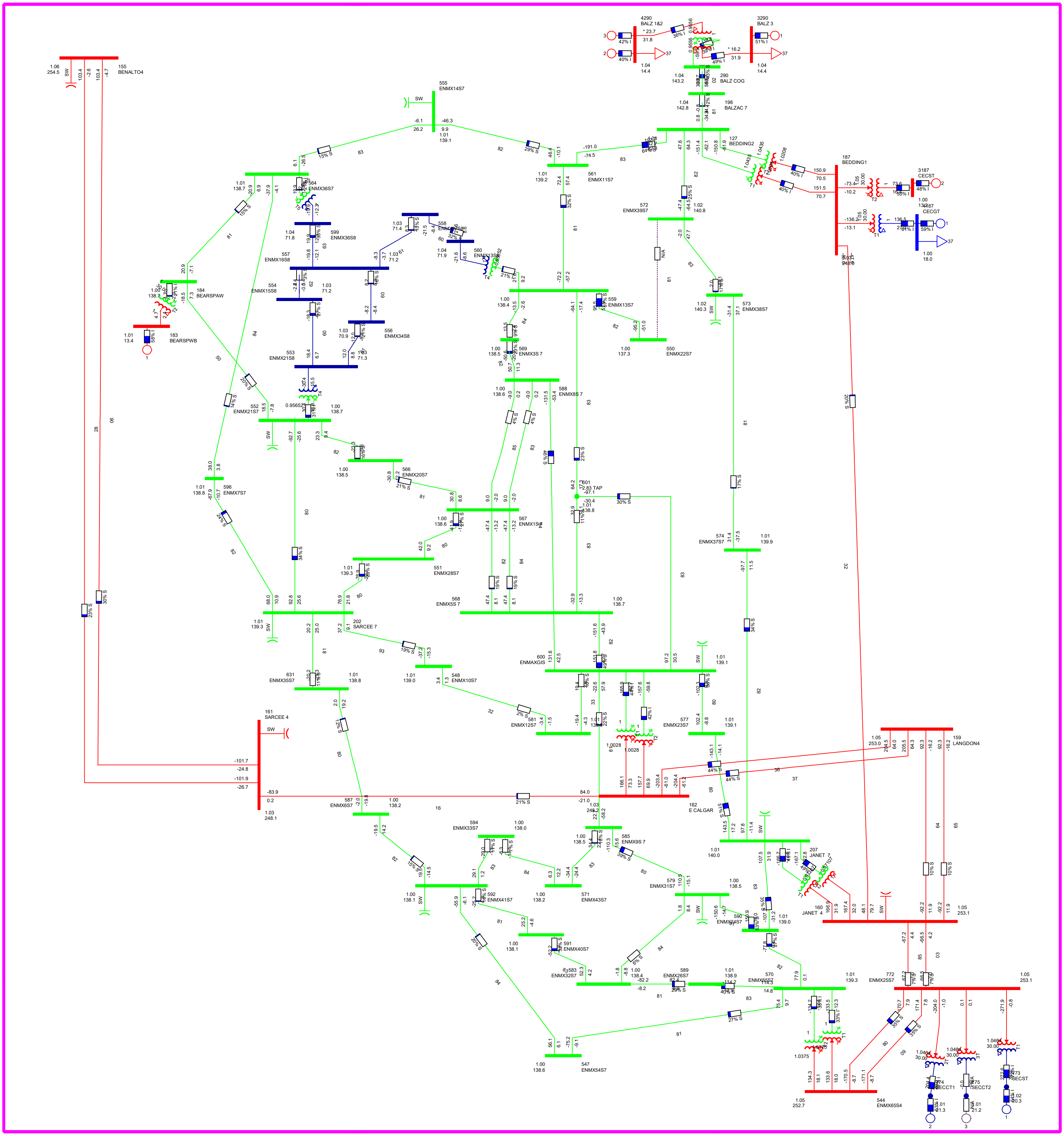

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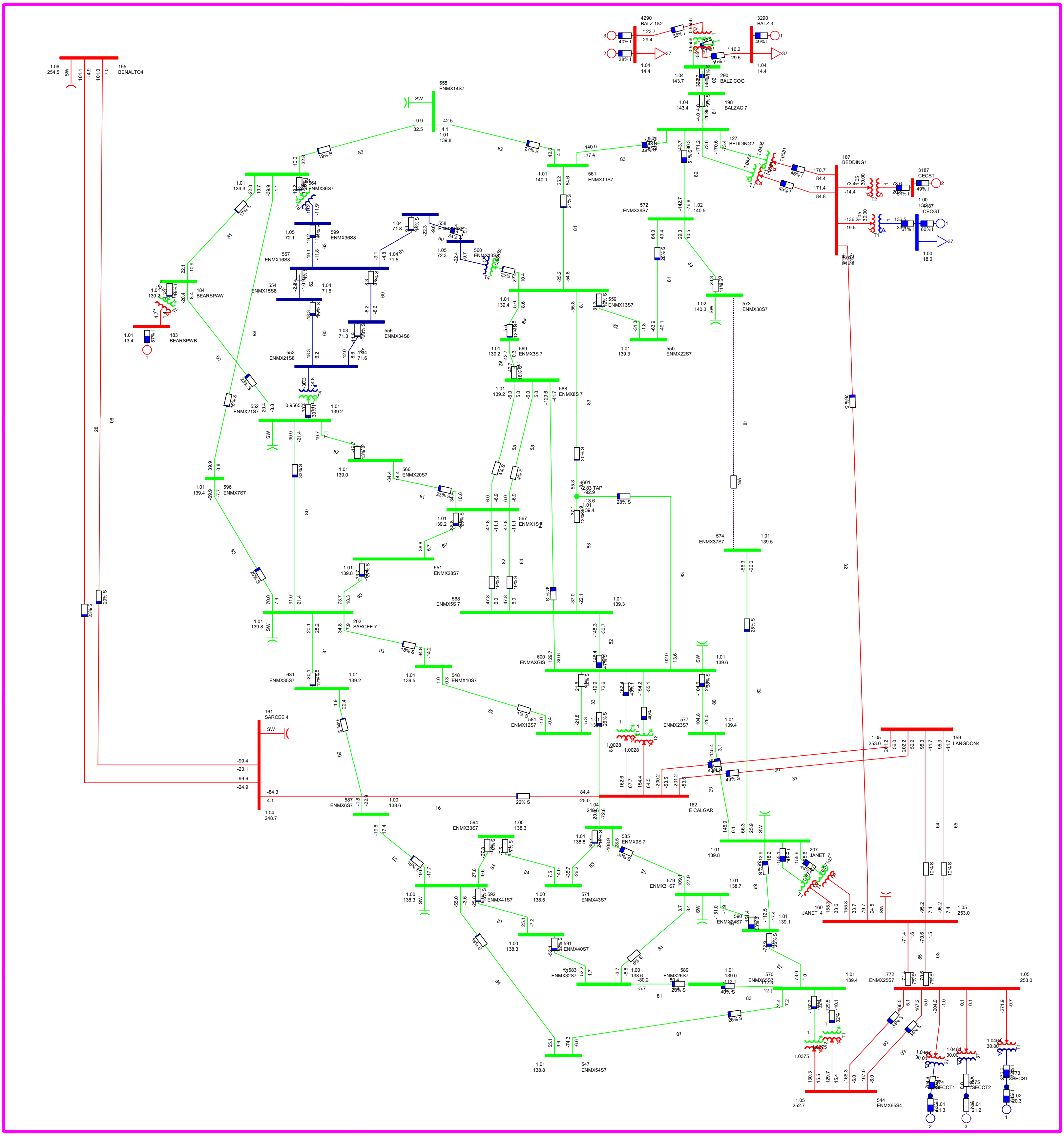

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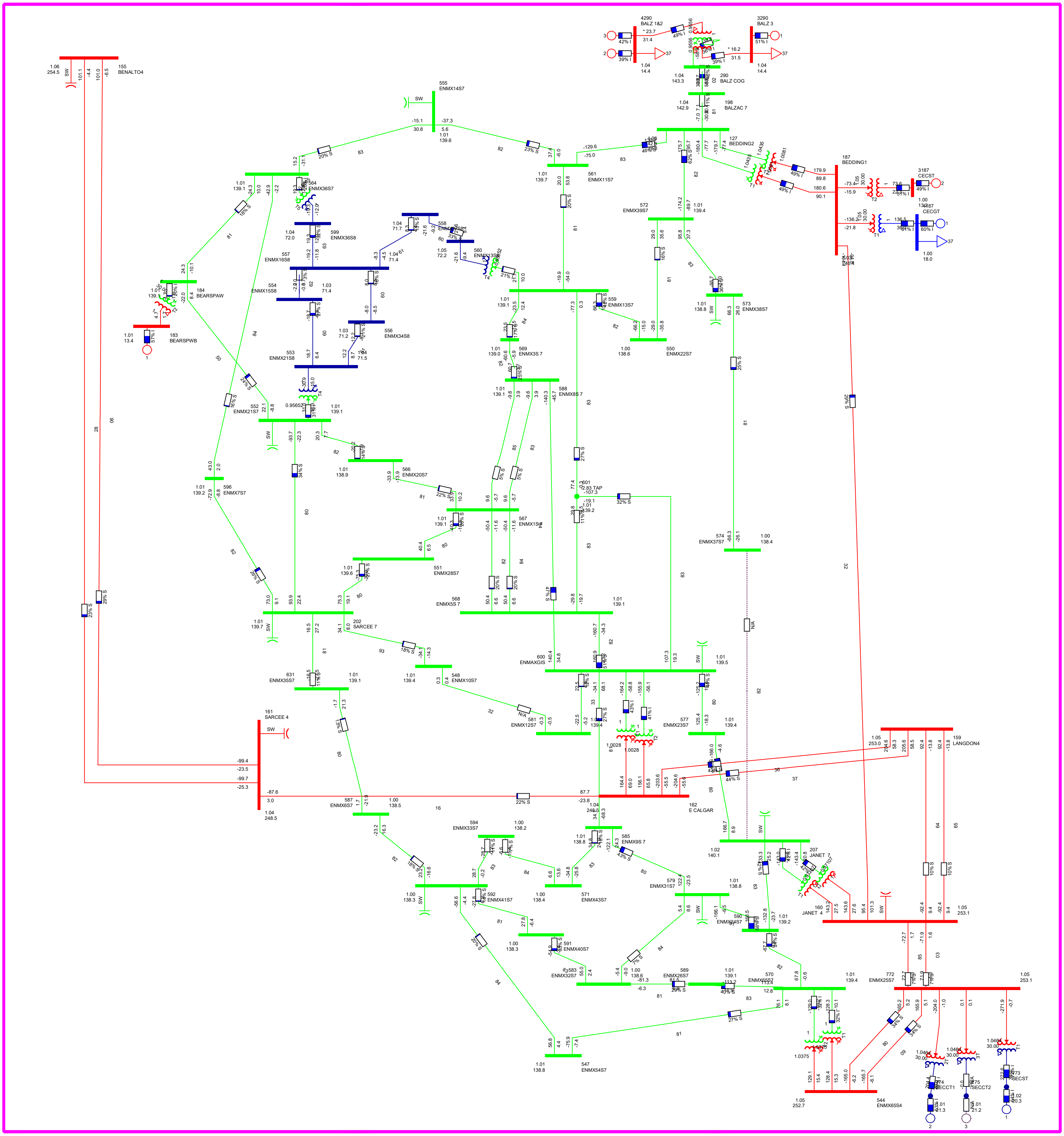

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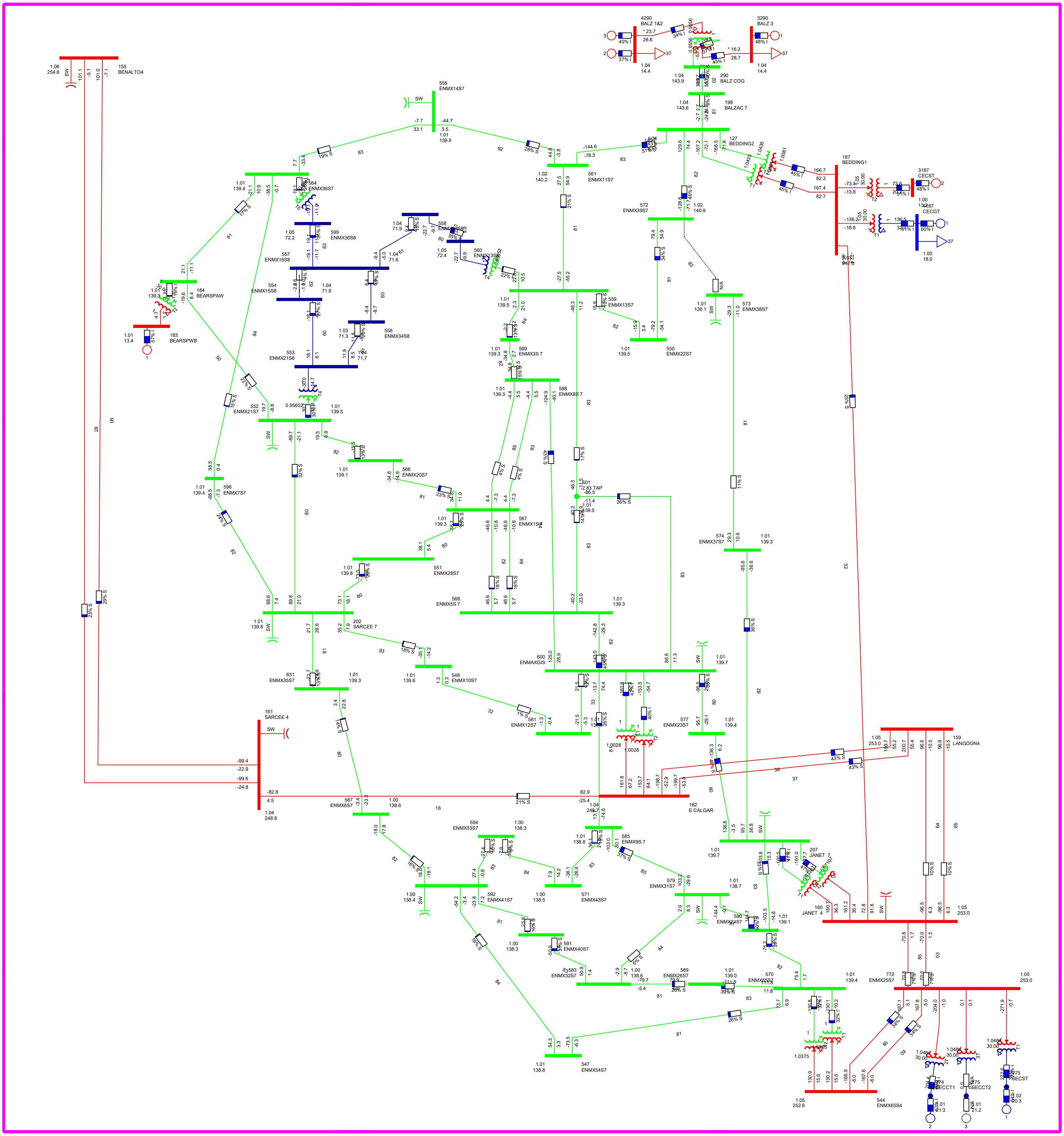

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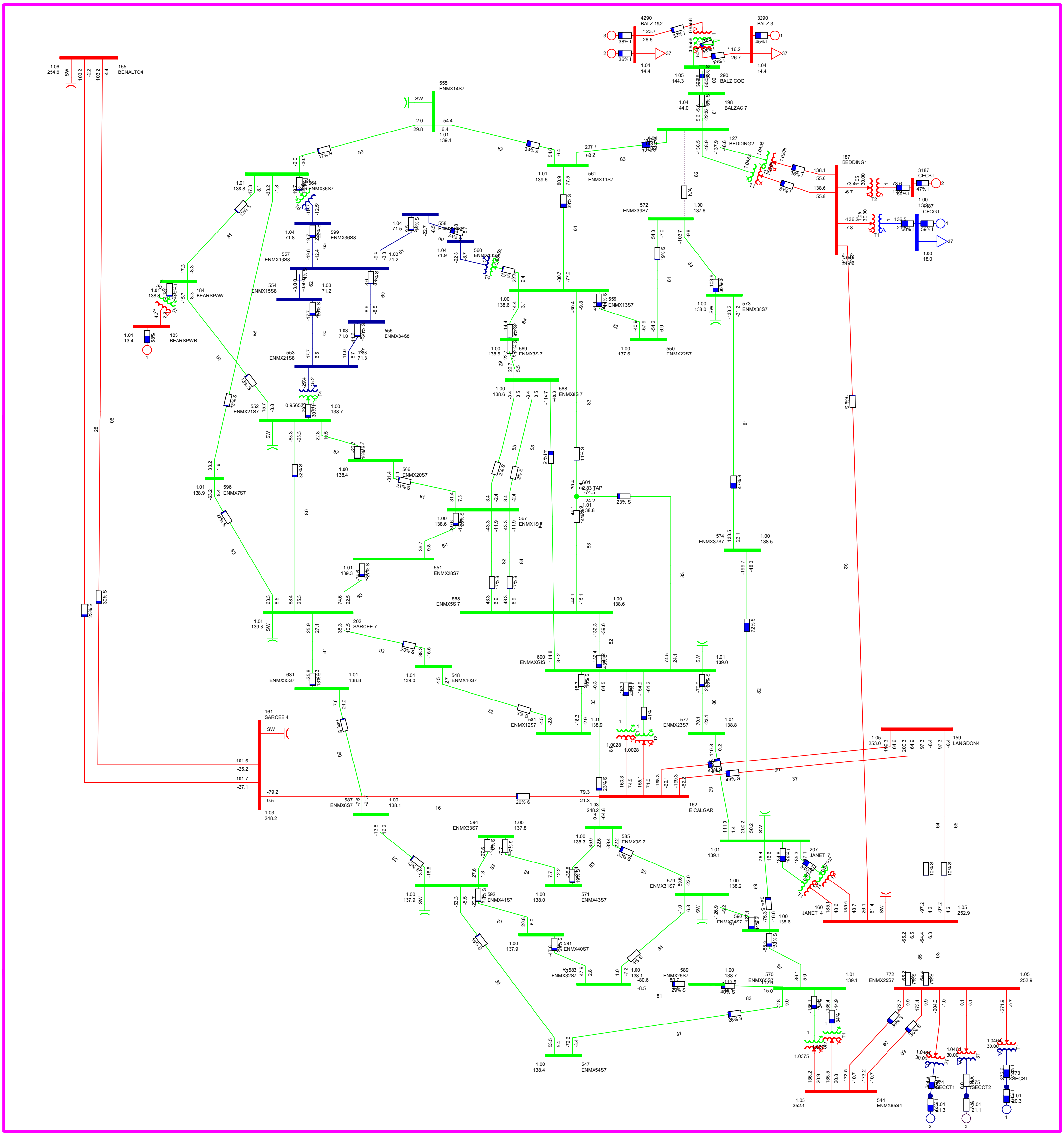

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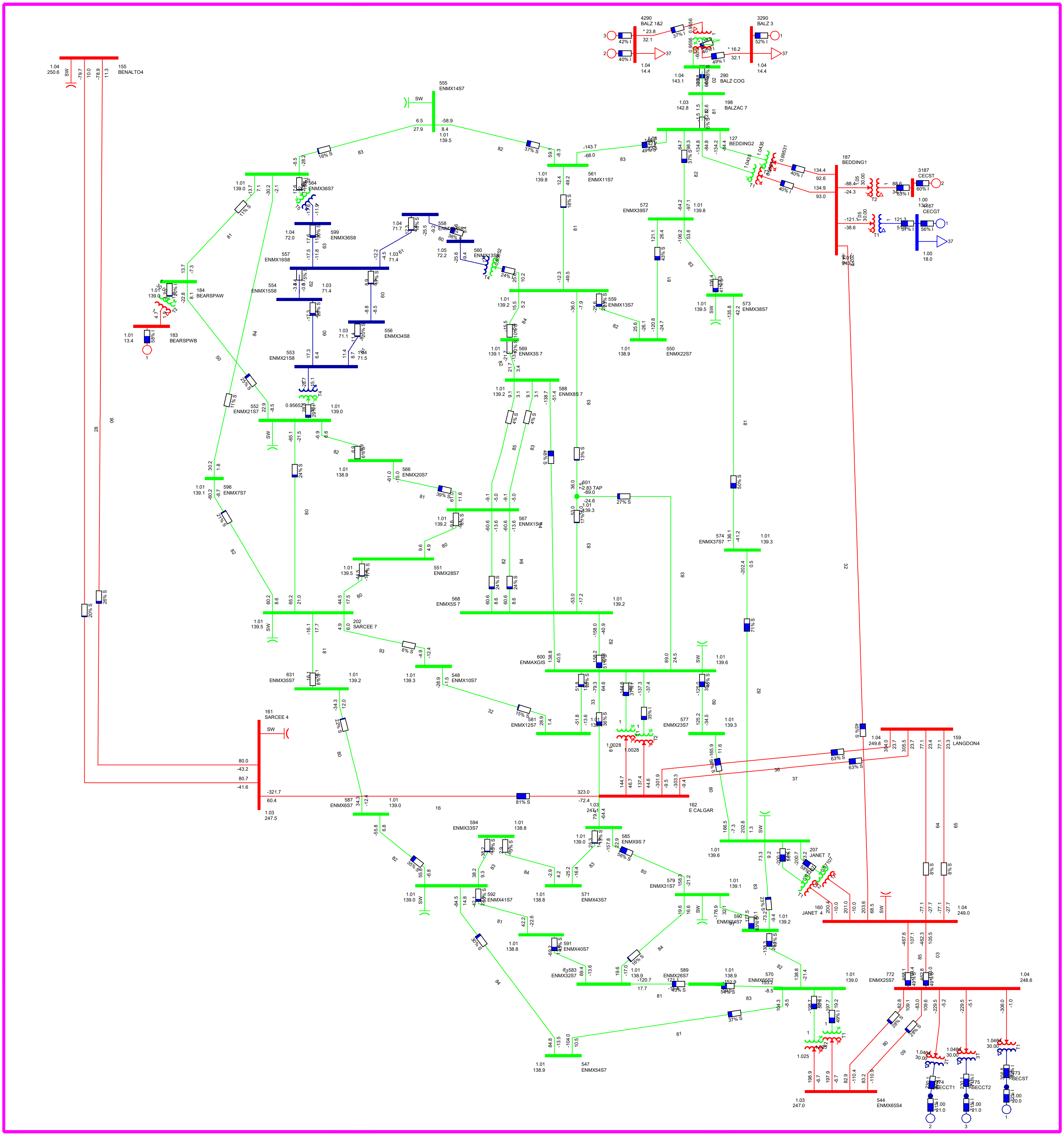

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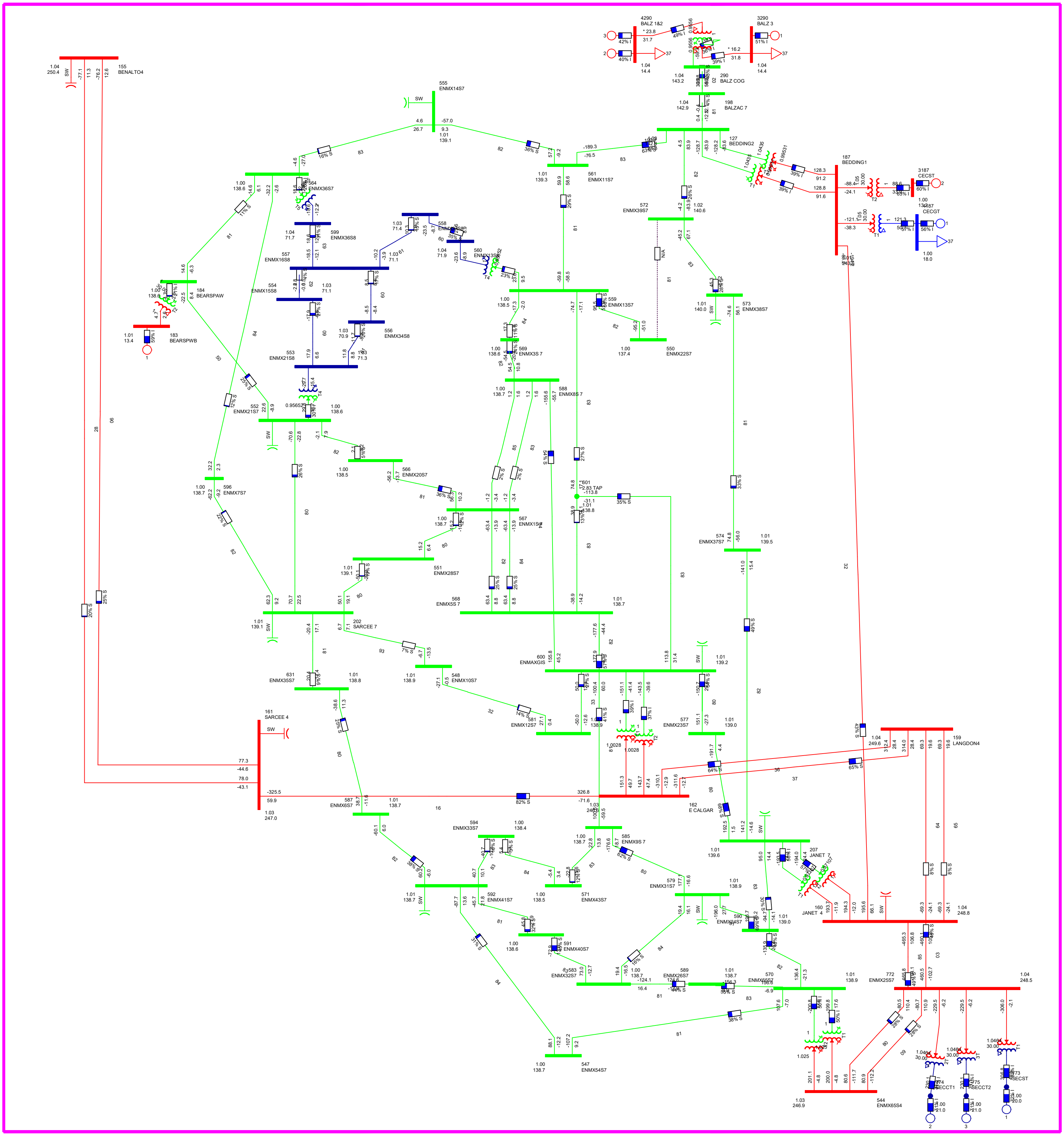

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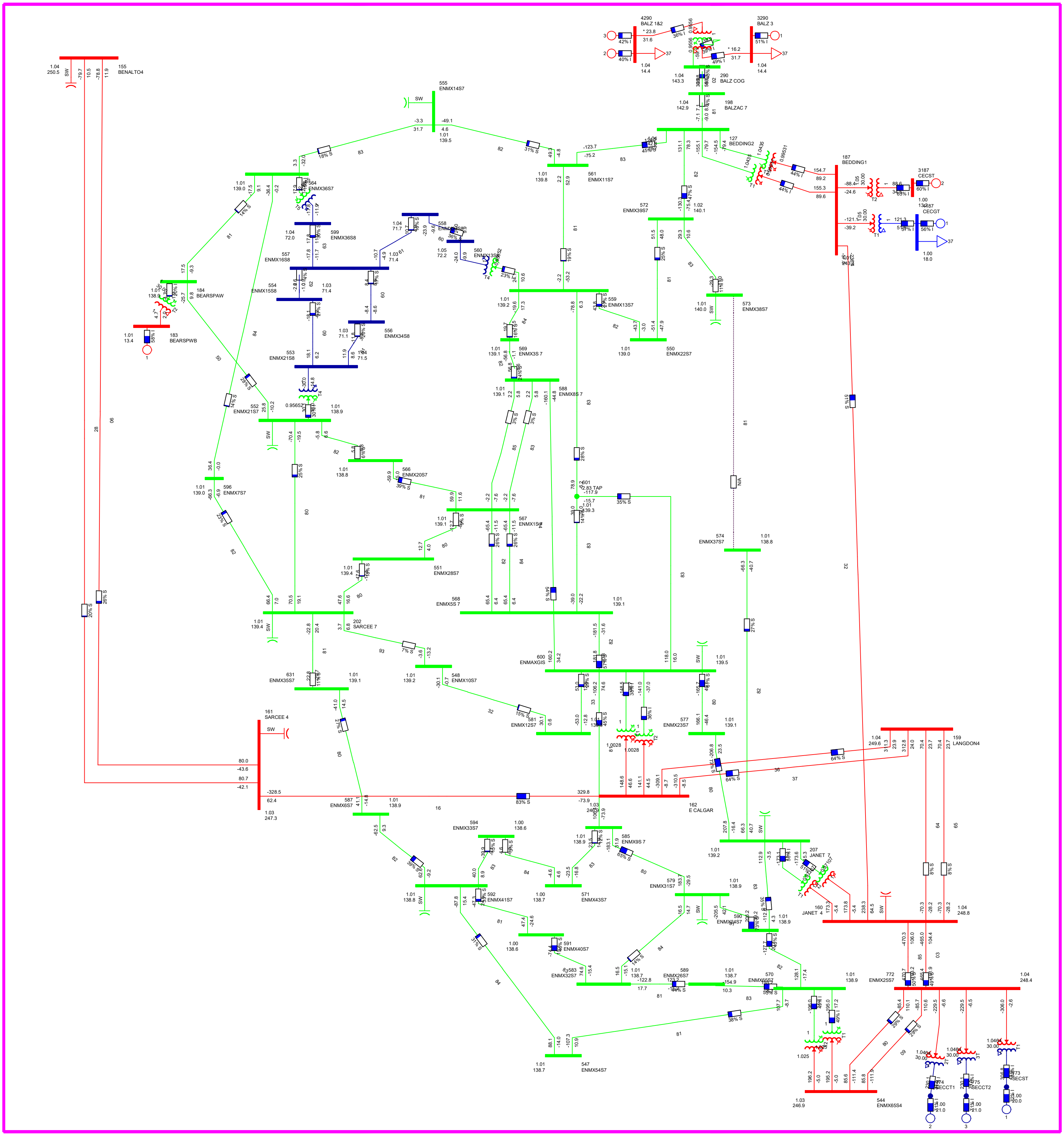

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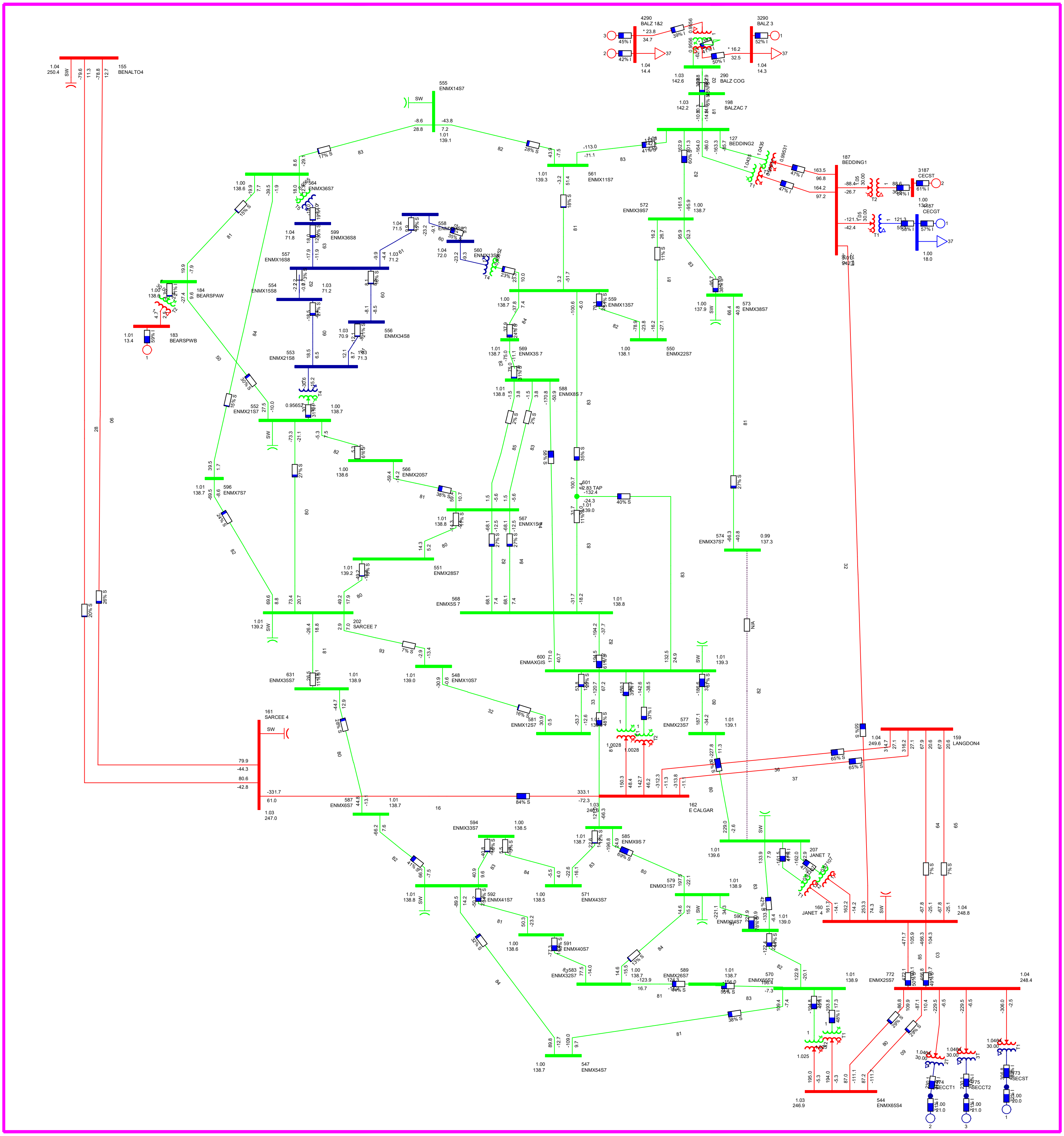

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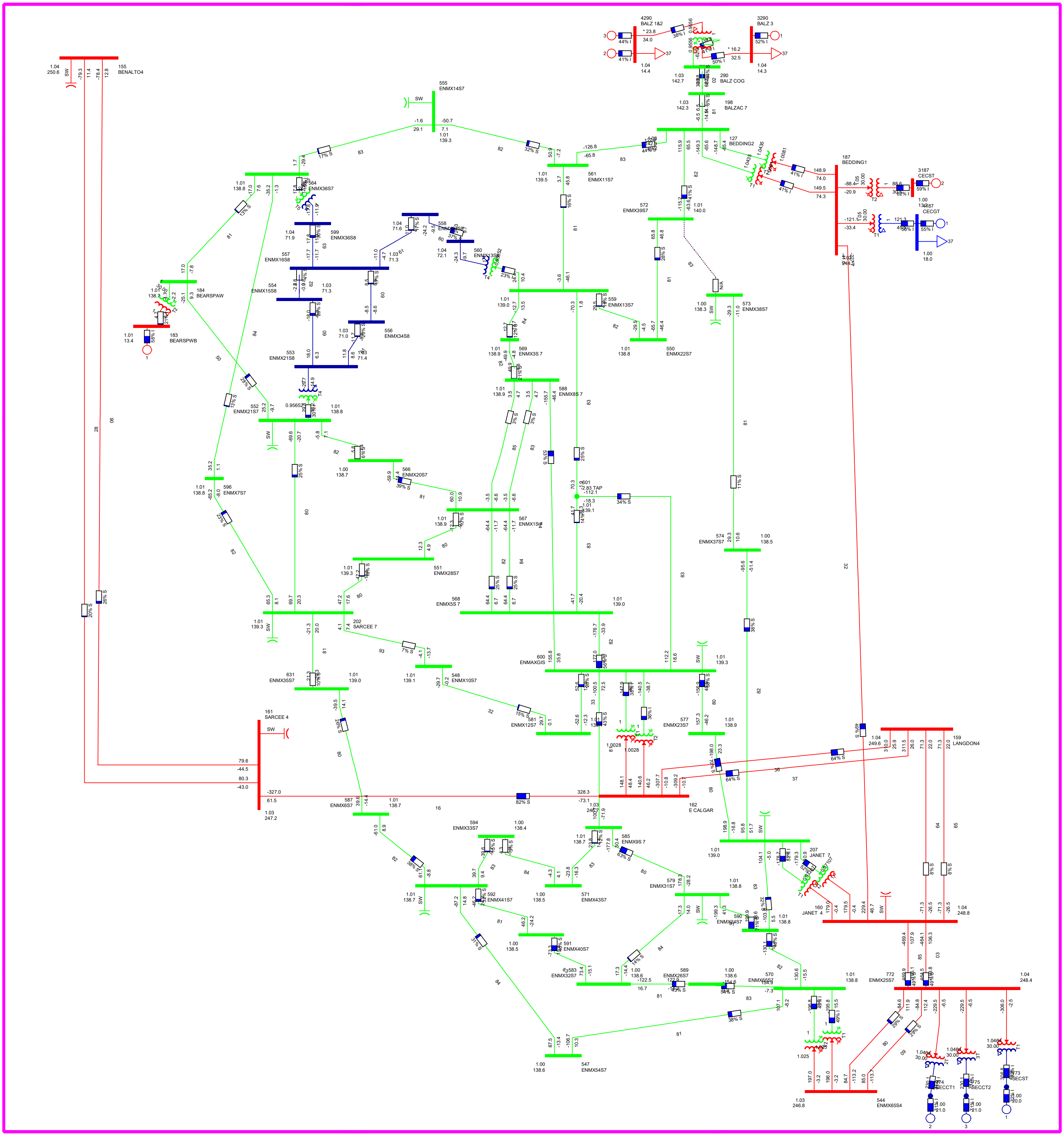

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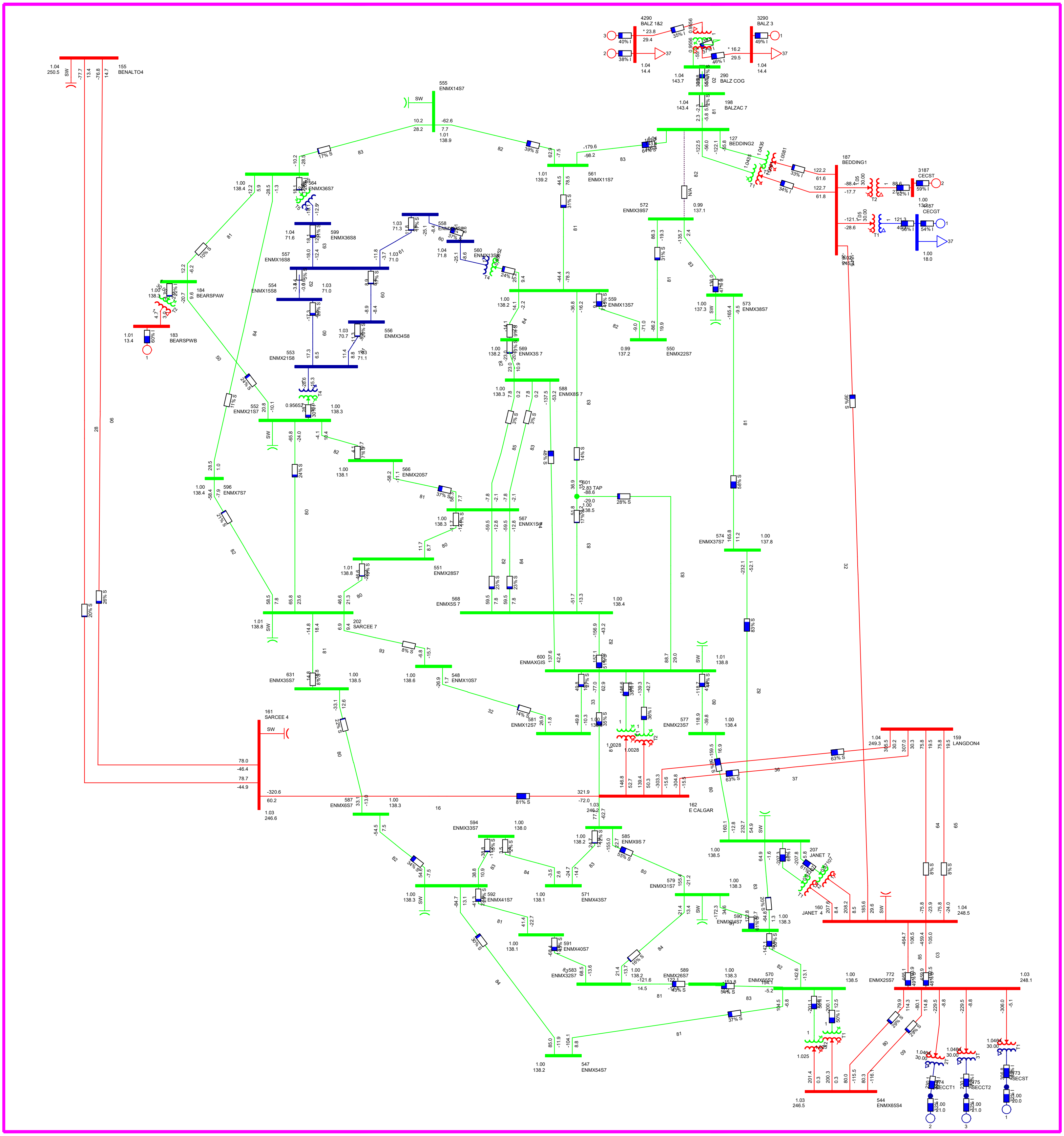

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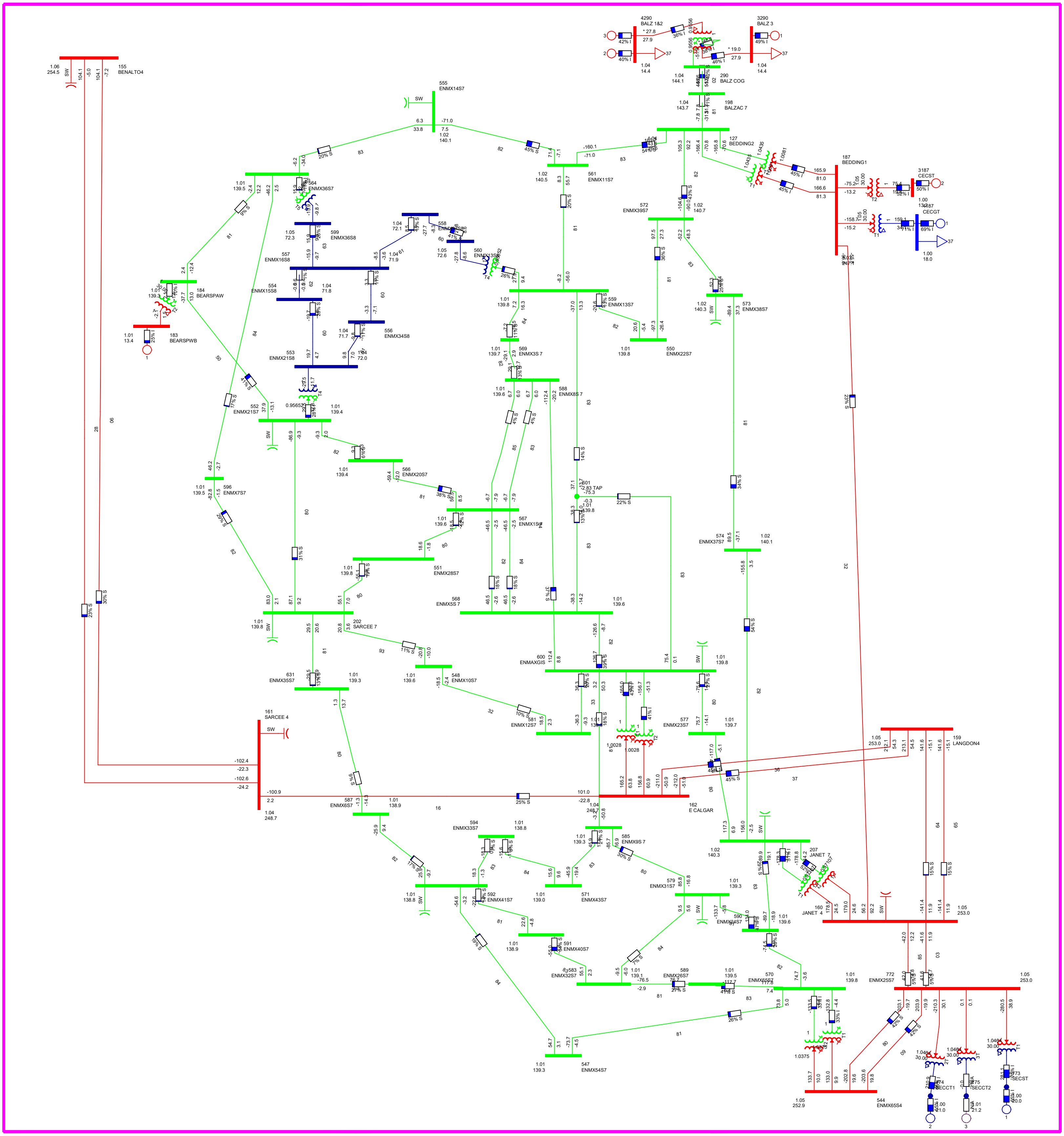

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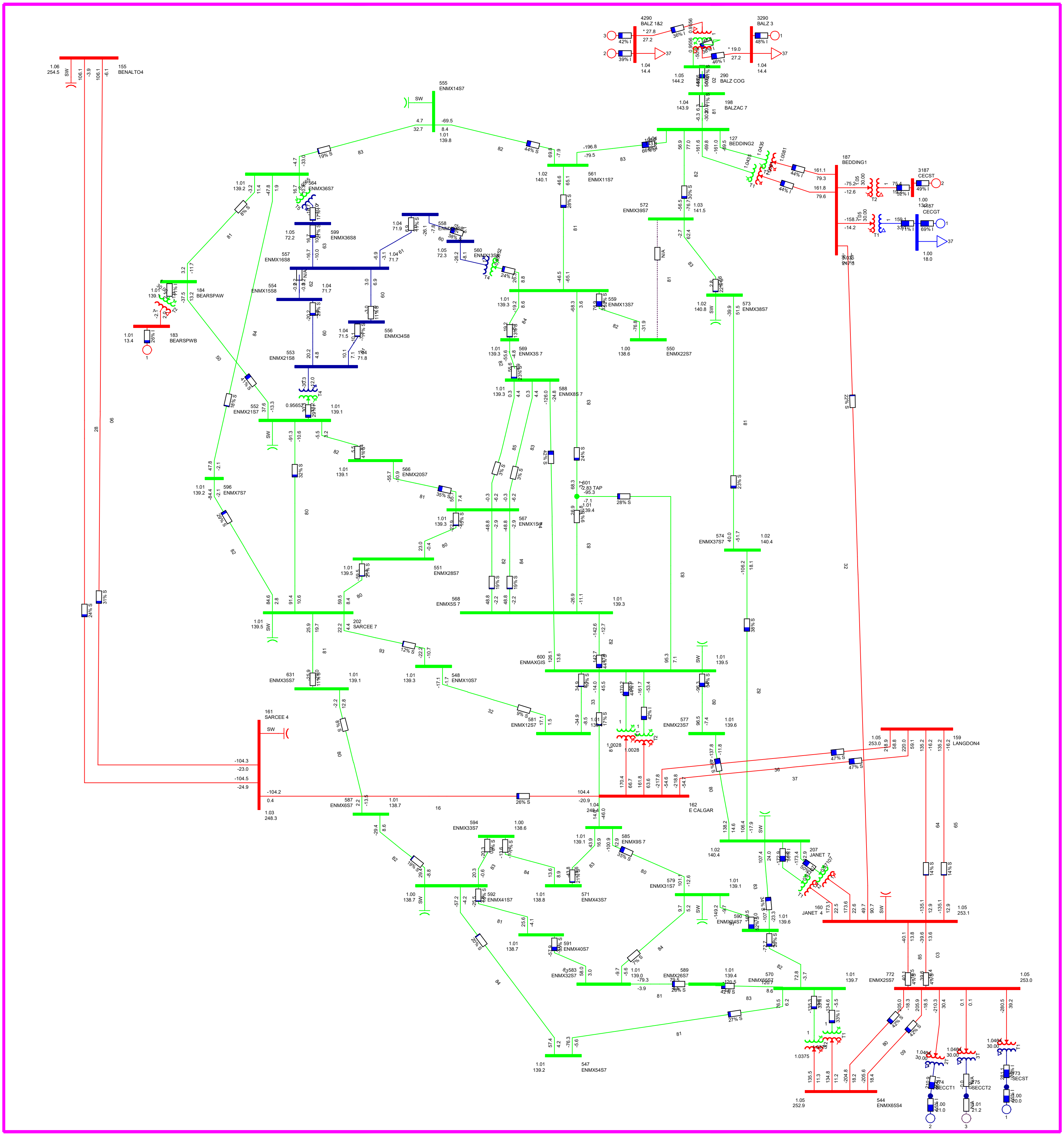

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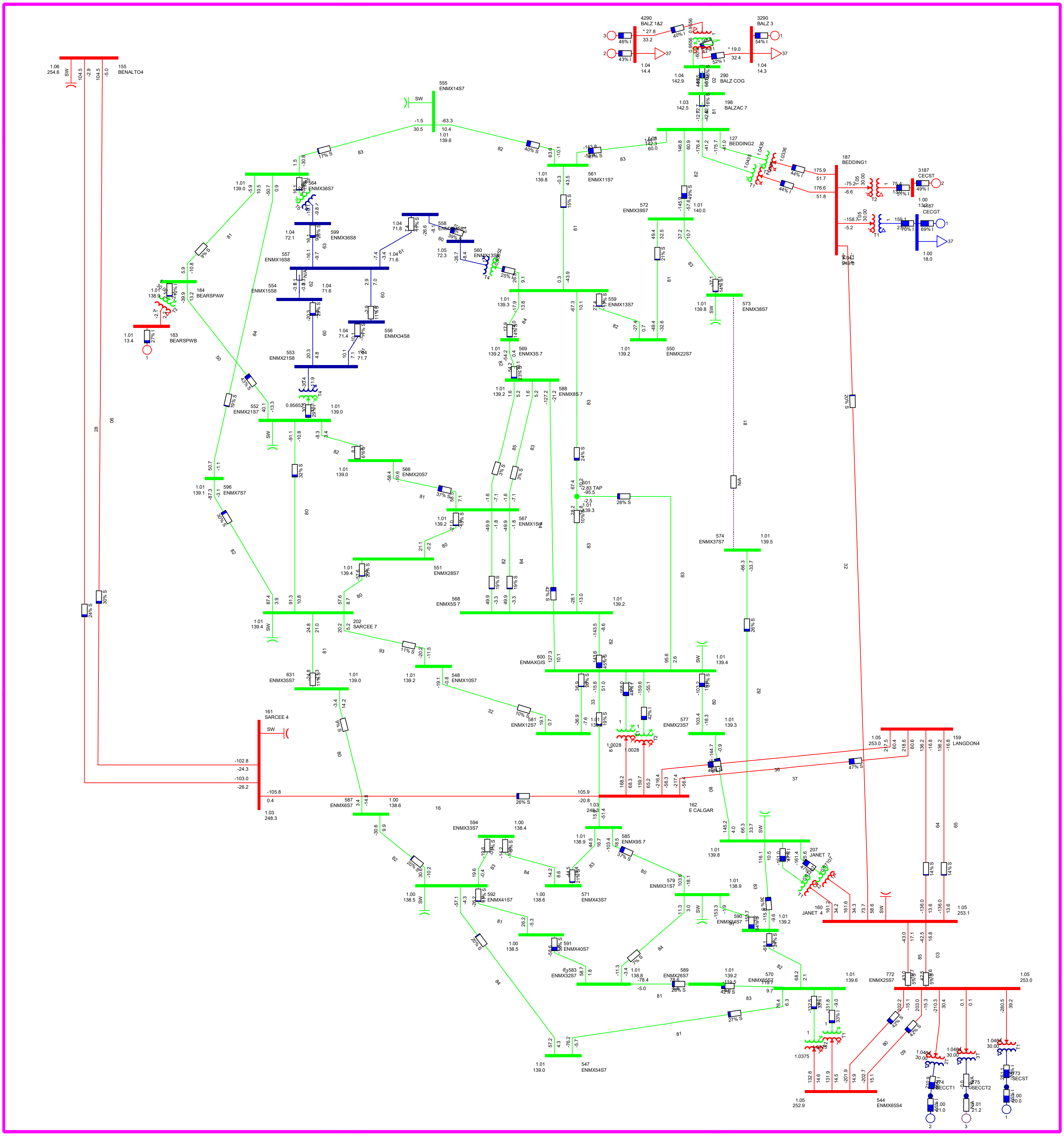

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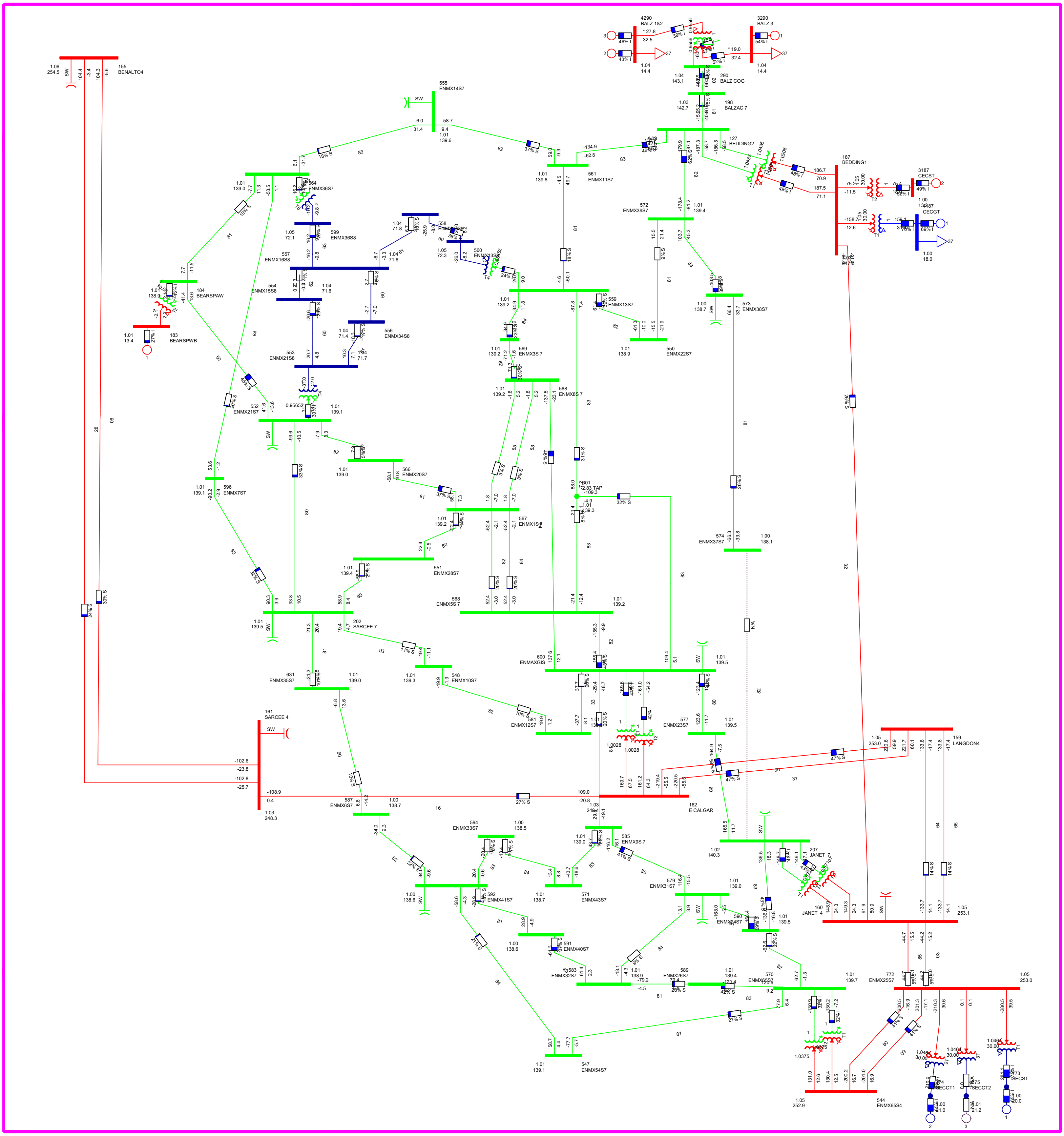

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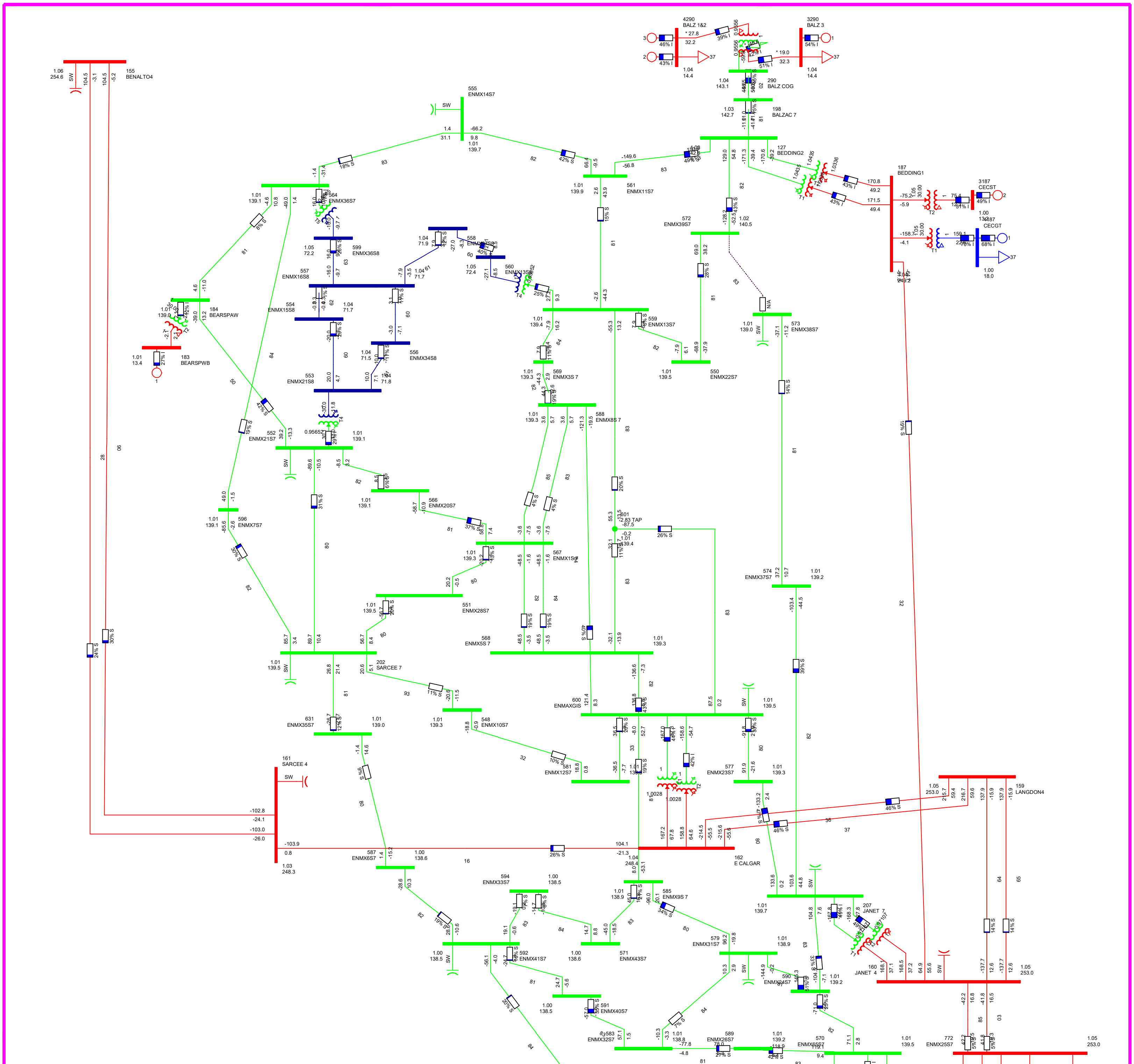

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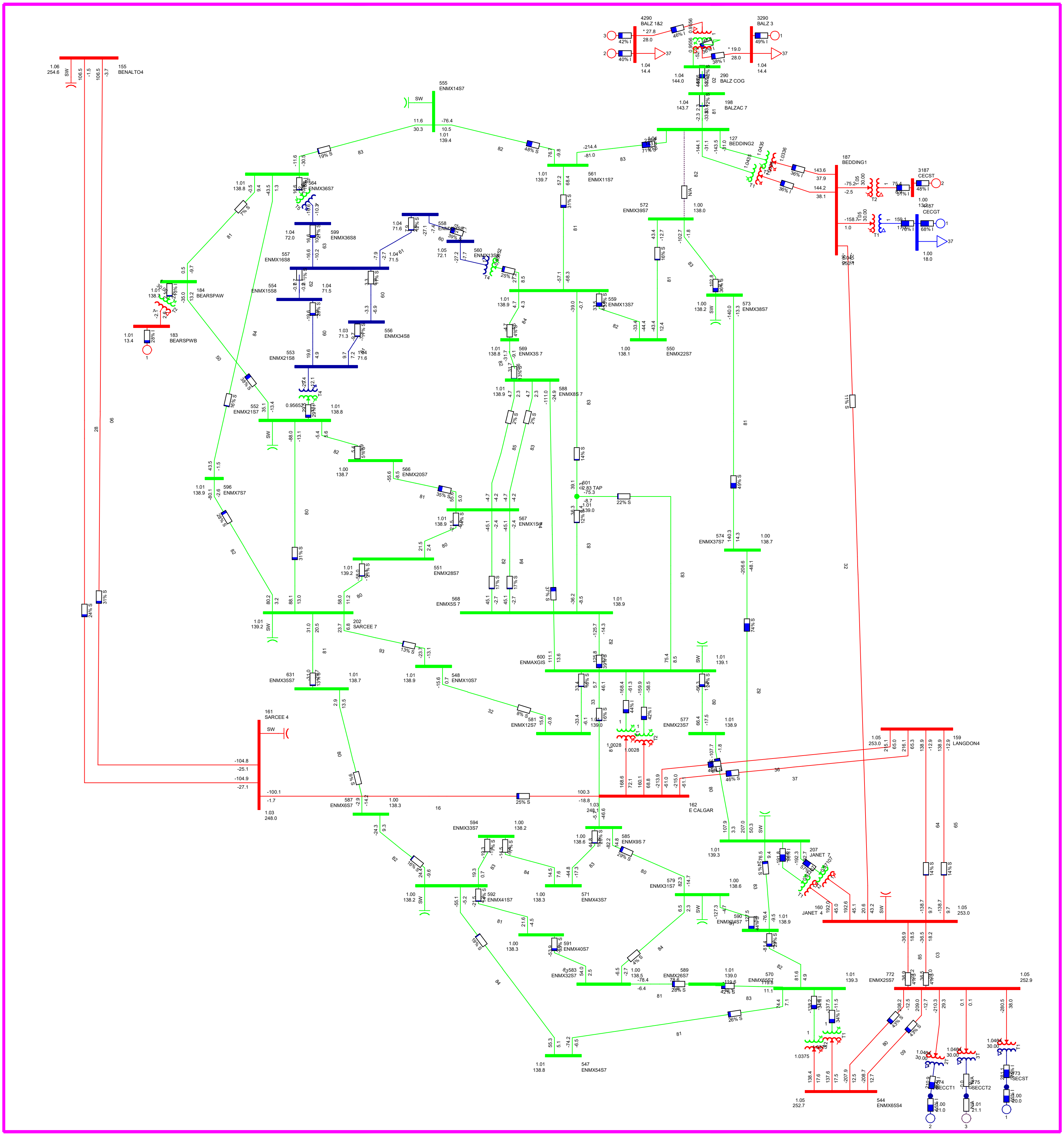

# Attachment A4
# Post-Project Voltage Stability Diagram

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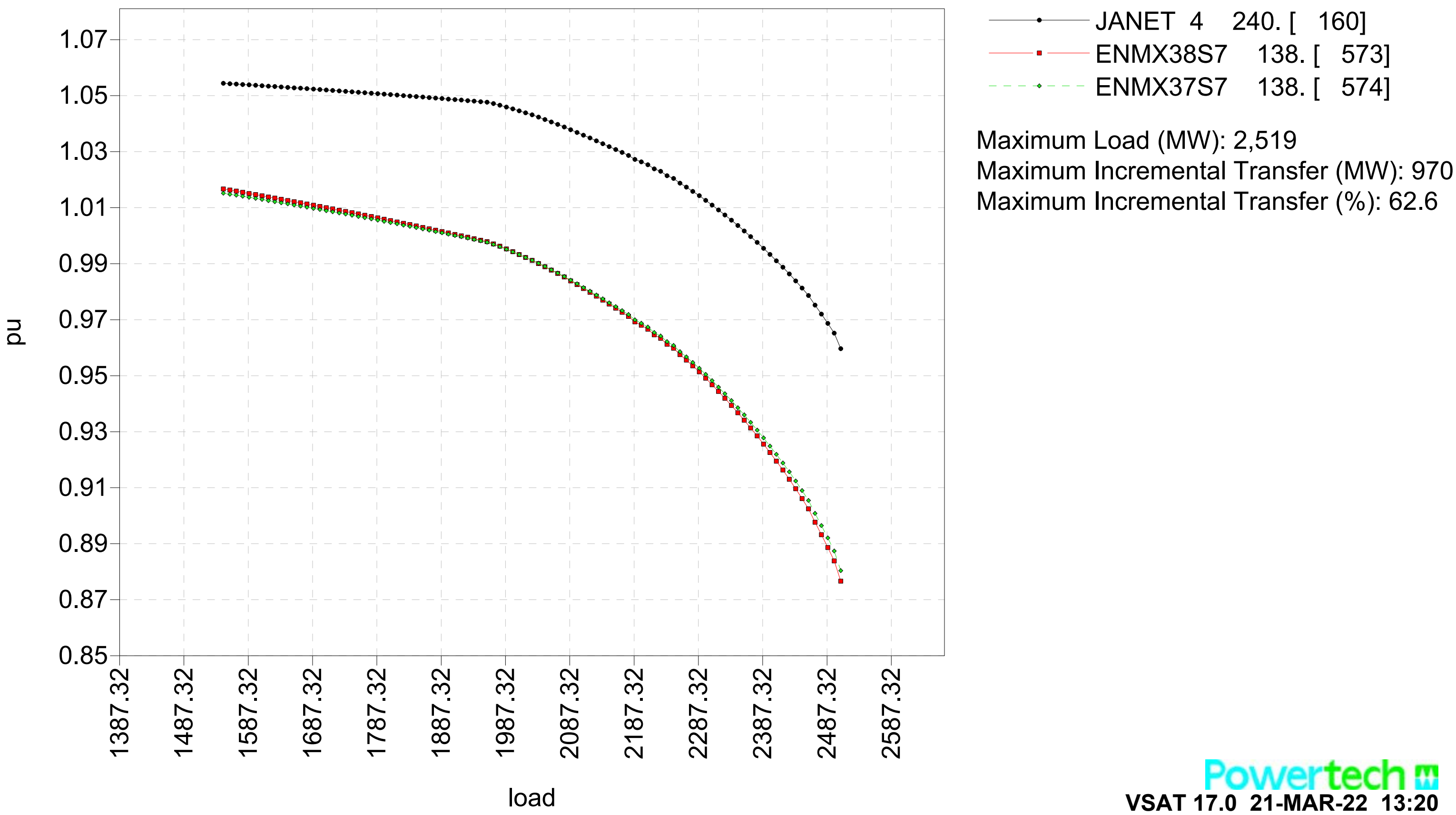
**Bus Voltage (pu) Contingency: Pre-Contingency**




Powertech
VSAT 17.0 21-MAR-22 13:20

**2021RC_2025WP_CALGARY-LOW_TIE-ECON_WIND-0_P**
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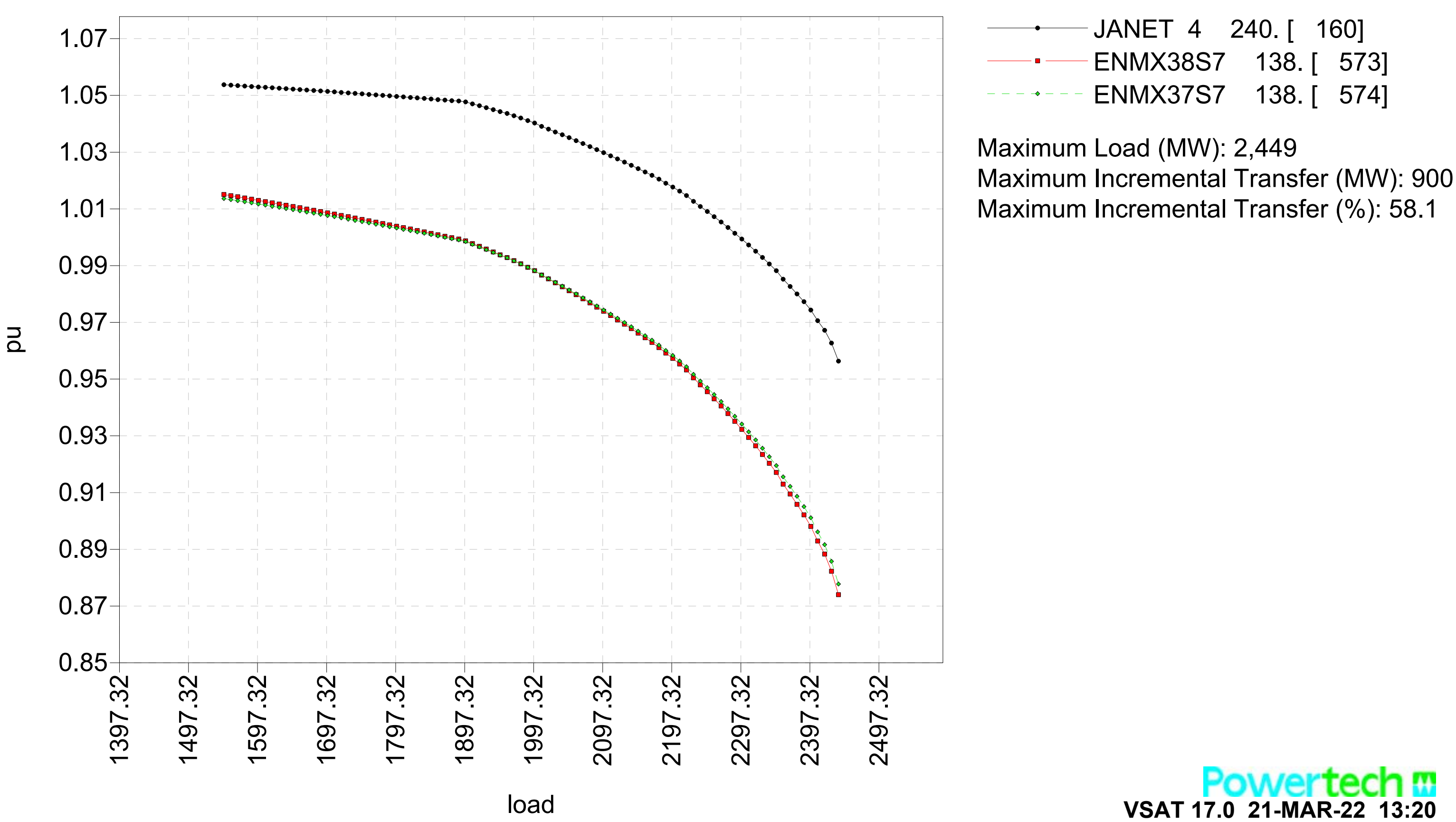
**Bus Voltage (pu) Contingency: 906L**




Powertech
VSAT 17.0 21-MAR-22 13:20

**2021RC_2025WP_CALGARY-LOW_TIE-ECON_WIND-0_P**
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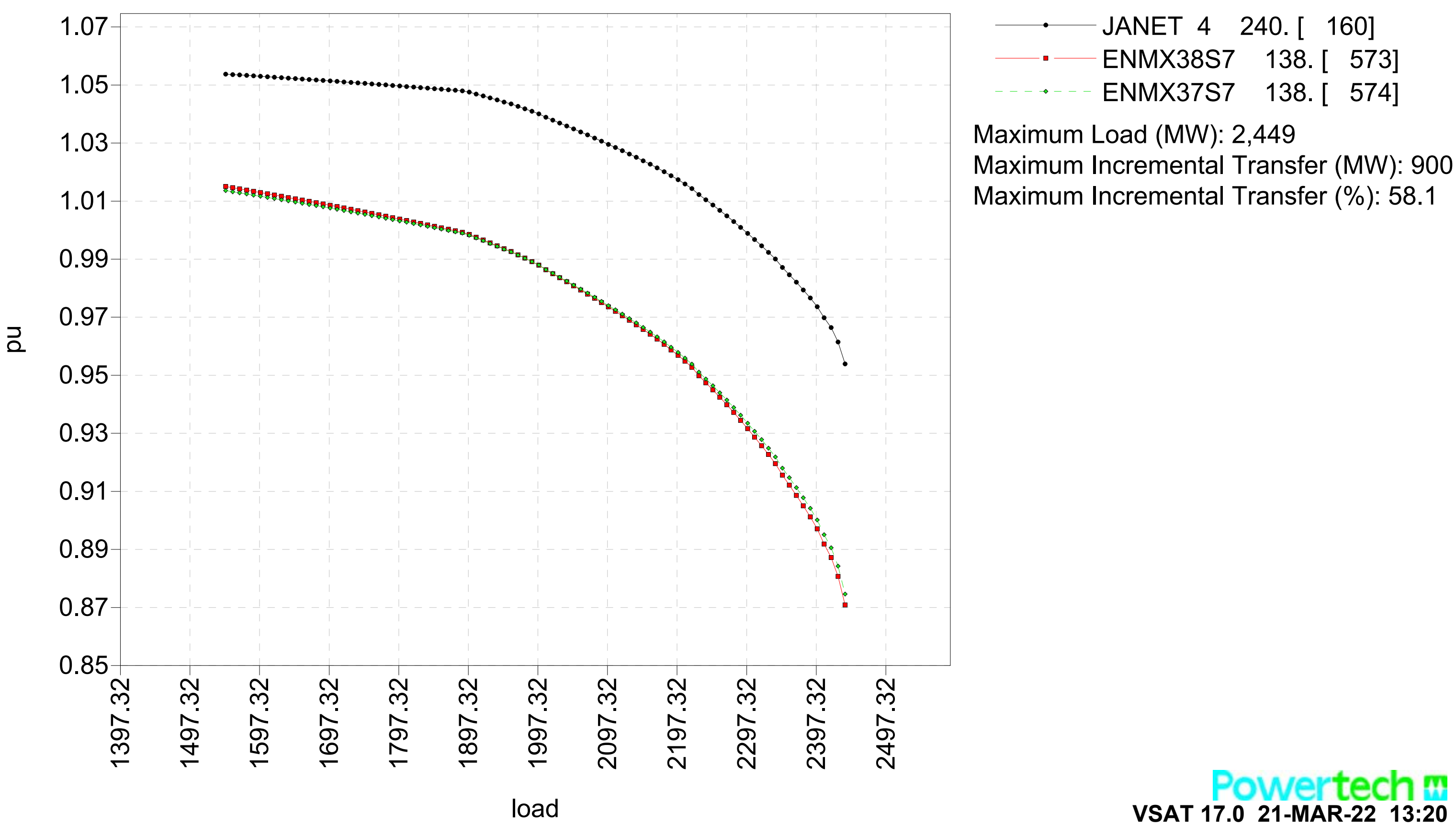
**Bus Voltage (pu) Contingency: 928L**




**2021RC_2025WP_CALGARY-LOW_TIE-ECON_WIND-0_P**
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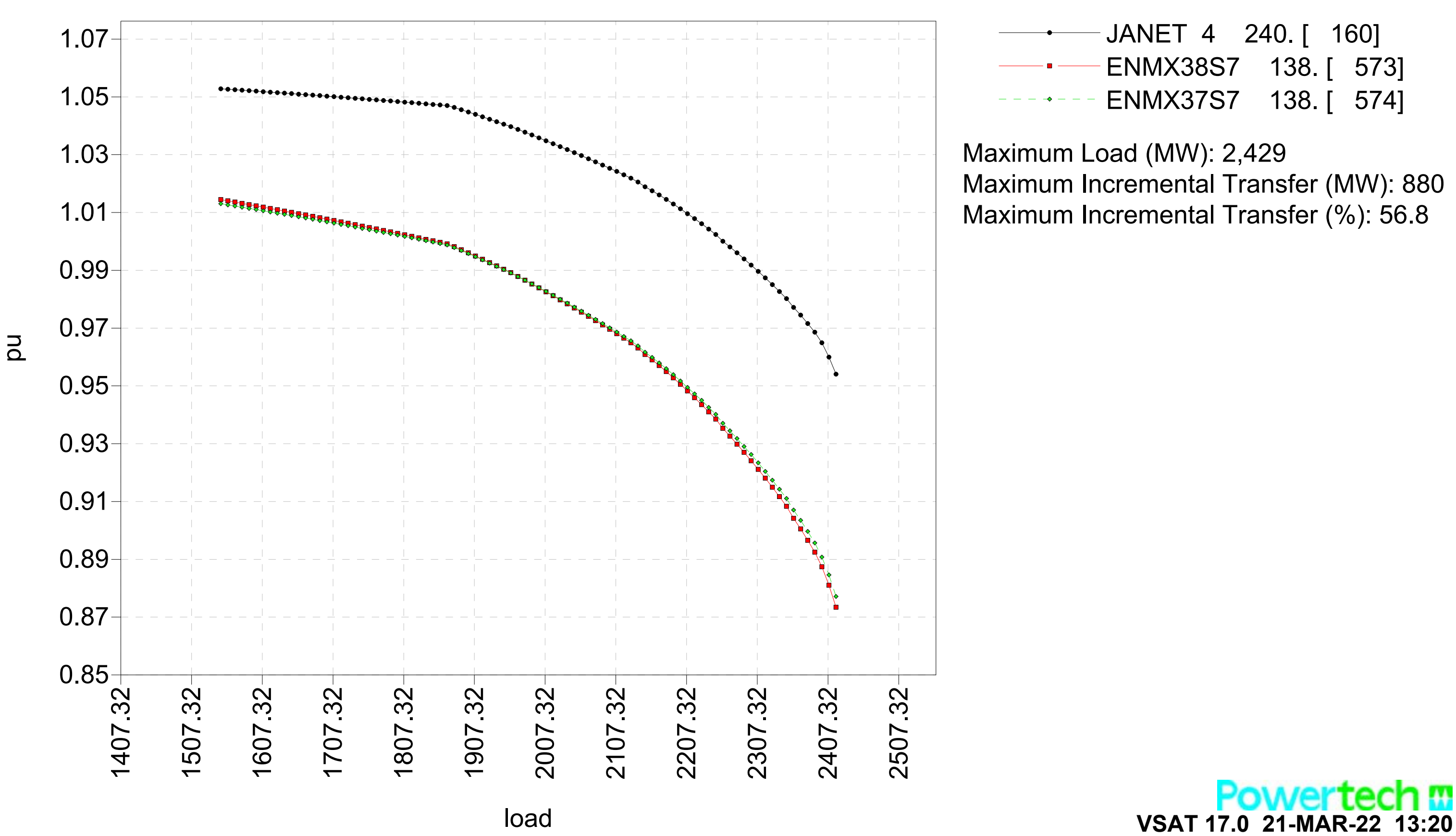
**Bus Voltage (pu) Contingency: WATL**



**2021RC_2025WP_CALGARY-LOW_TIE-ECON_WIND-0_P**
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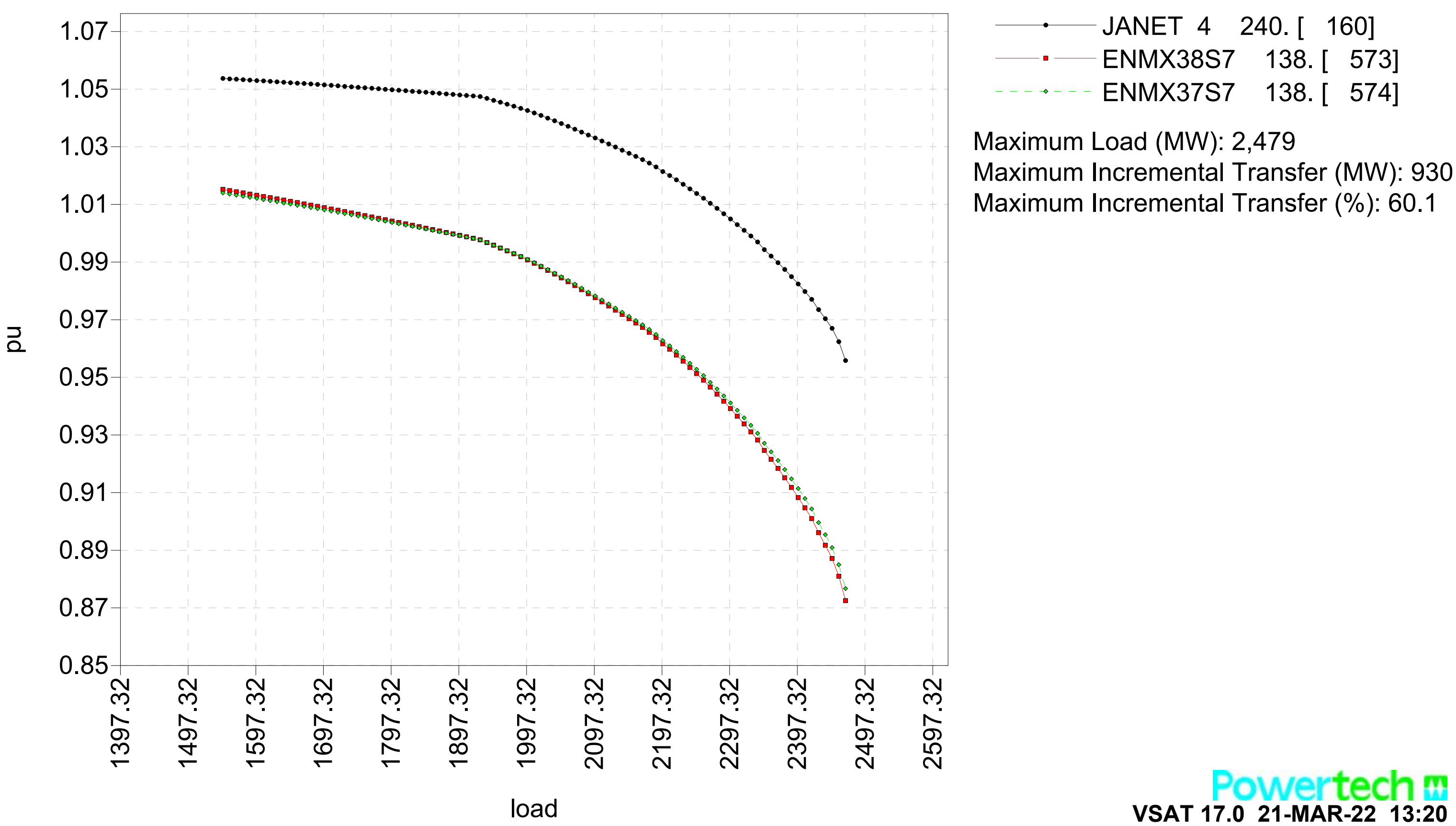


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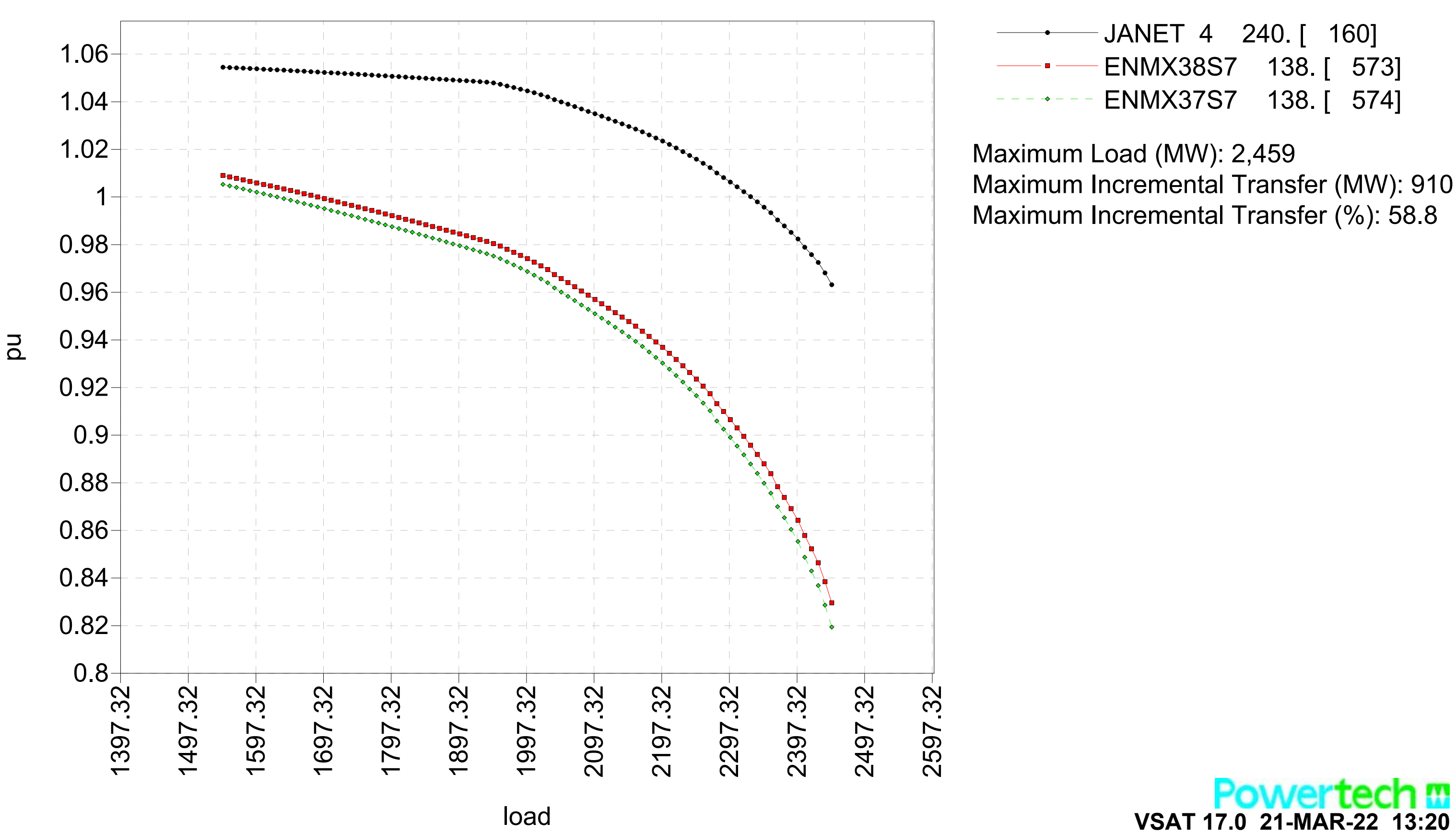
**Bus Voltage (pu)   Contingency: 37.82L**



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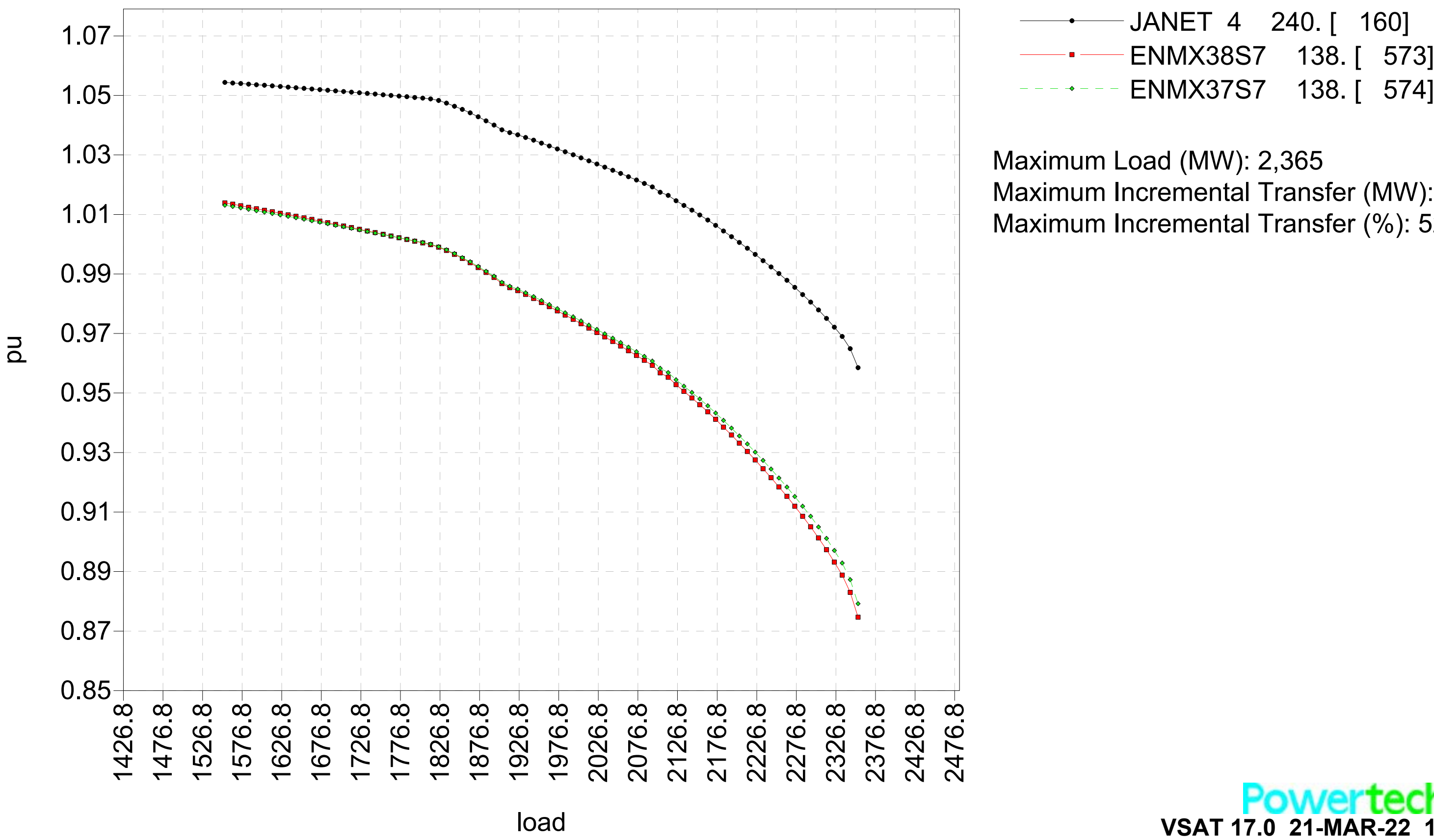
**Bus Voltage (pu)   Contingency: Pre-Contingency**




Maximum Load (MW): 2,365
Maximum Incremental Transfer (MW): 810
Maximum Incremental Transfer (%): 52.1

Powertech
**VSAT 17.0 21-MAR-22 18:03**

**2021RC_2025SP_CALGARY-LOW_TIE-ECON_WIND-0_P**
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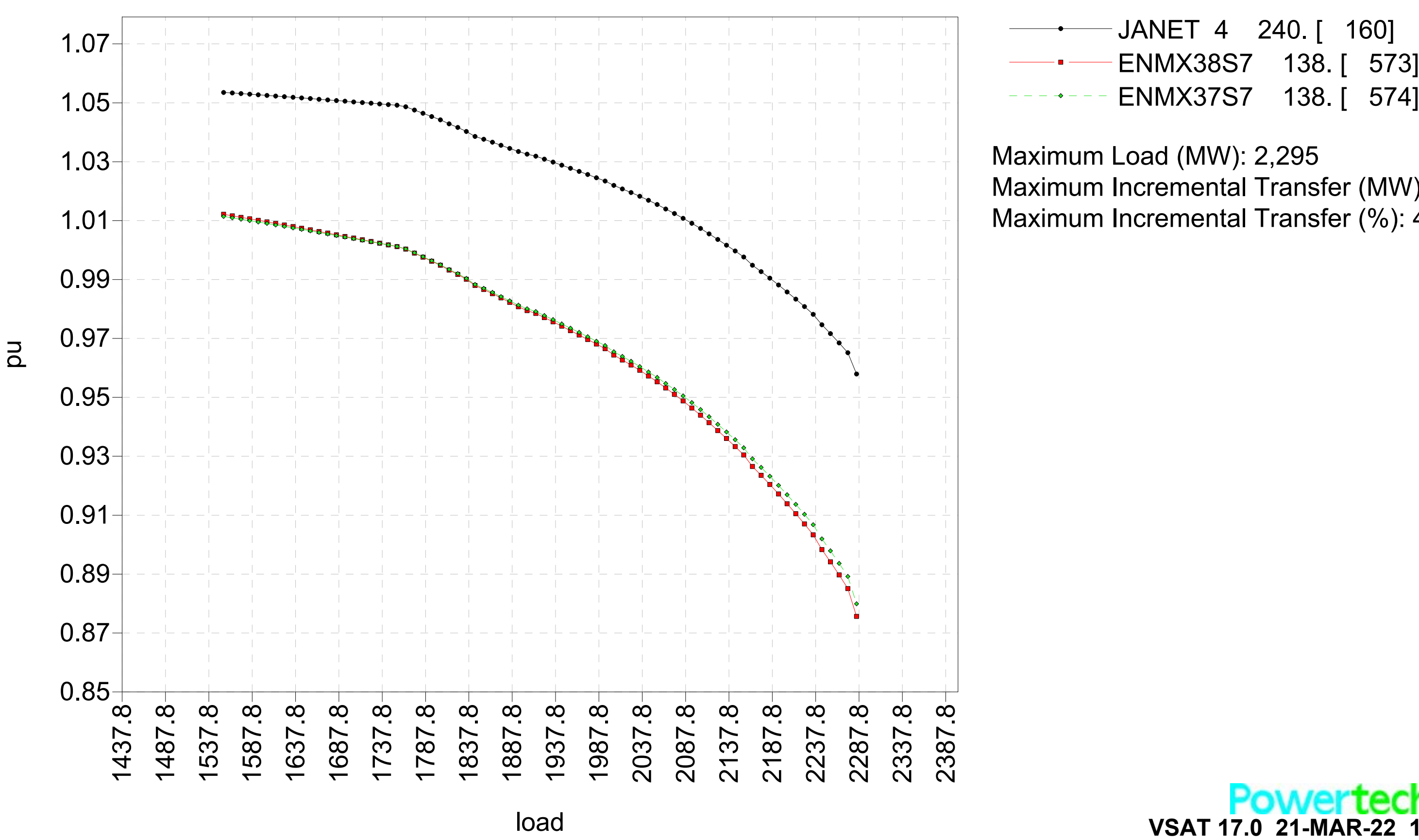
**Bus Voltage (pu)   Contingency: 906L**




Maximum Load (MW): 2,295
Maximum Incremental Transfer (MW): 740
Maximum Incremental Transfer (%): 47.6

Powertech
**VSAT 17.0 21-MAR-22 18:03**

**2021RC_2025SP_CALGARY-LOW_TIE-ECON_WIND-0_P**
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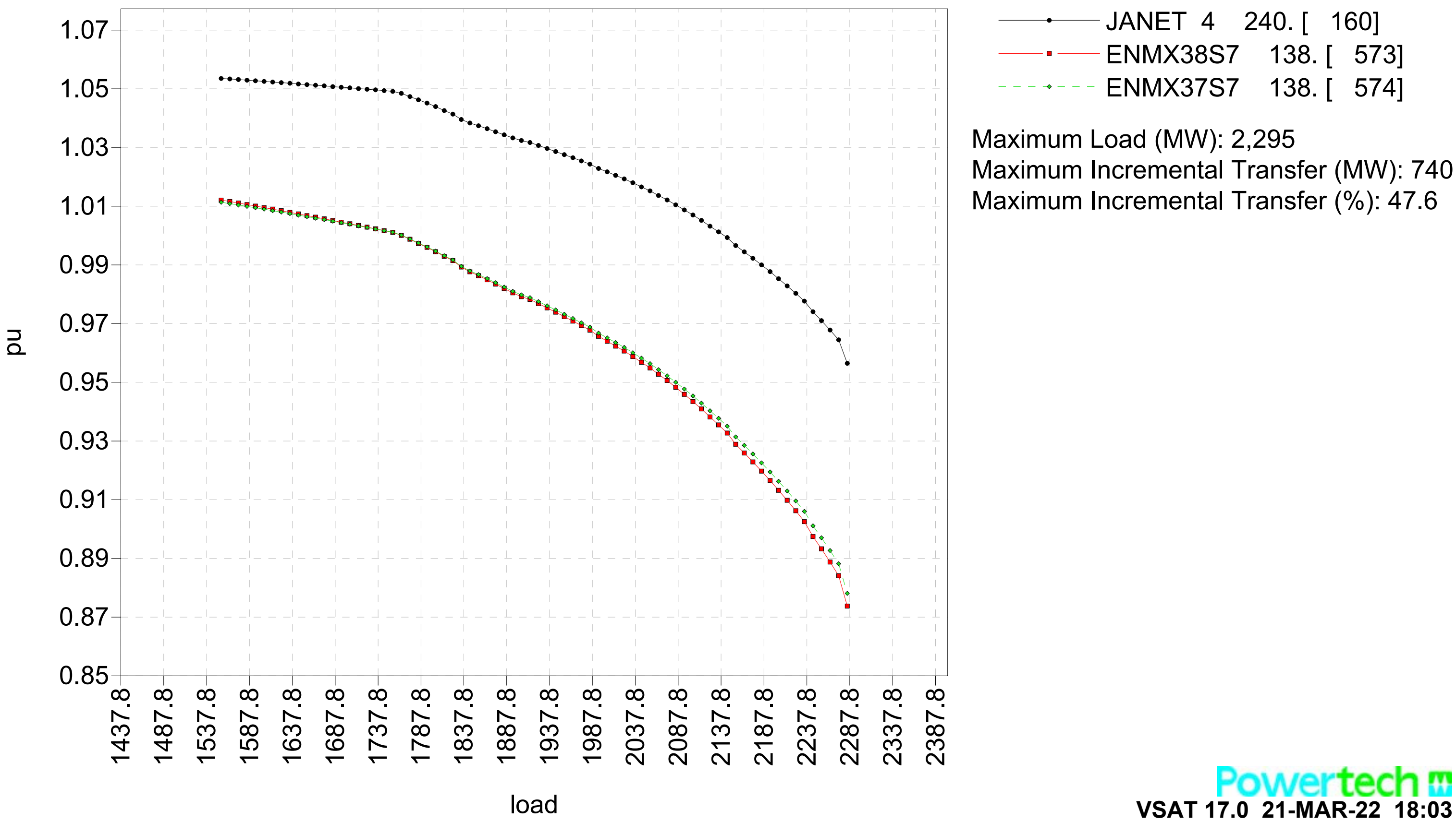
**Bus Voltage (pu)   Contingency: 928L**




**2021RC_2025SP_CALGARY-LOW_TIE-ECON_WIND-0_P**
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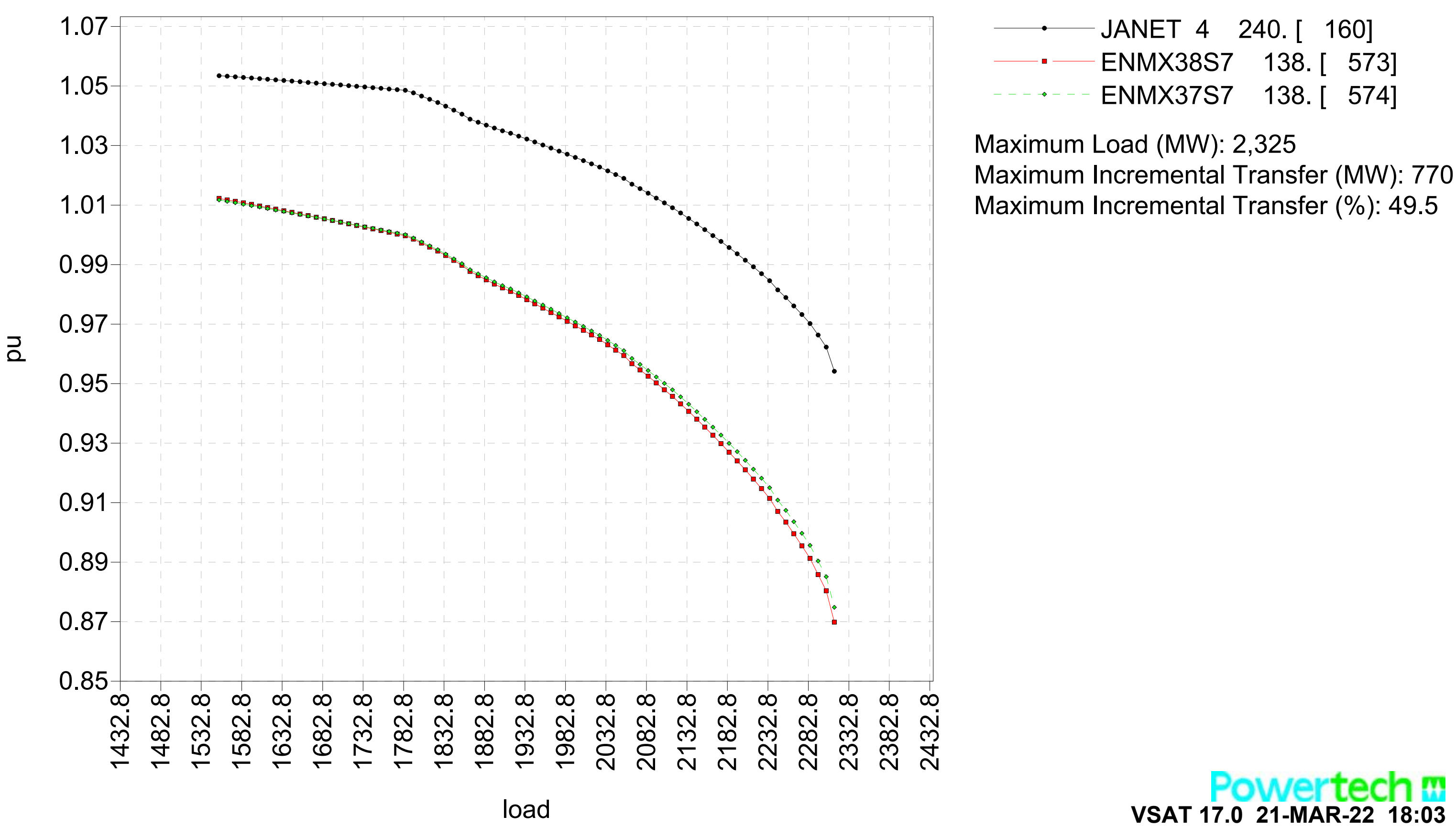

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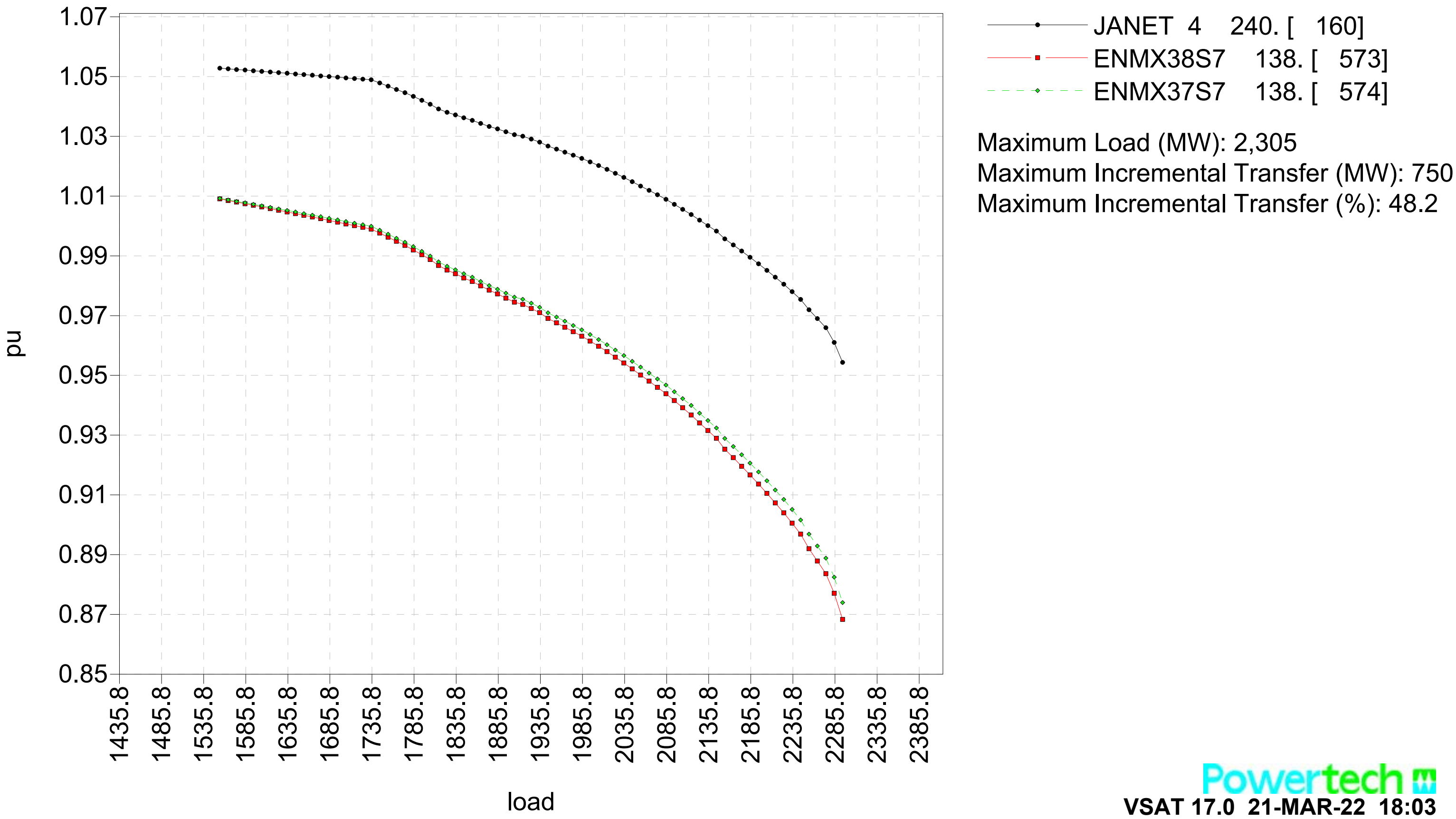


**2021RC_2025SP_CALGARY-LOW_TIE-ECON_WIND-0_P**
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**Bus Voltage (pu)   Contingency: 37.82L**